JAN 20 1925

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Aveling & Porter, Ltd.,
ROCHESTER.
Steam & Crude Oil Road Rollers, &c.
2581

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CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 19.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
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See half-page Advert. last week and next week. 2087

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 2591

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited,
BIRMINGHAM. 1241
See Advertisement last week, page 19.

Spencer-Hopwood & Kirke
PATENT BOILERS *See Page 49, Dec. 26.* 1994
Sole Makers: SPENCER-BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
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COVENTRY. 610

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Hurst, Nelson & Co., Ltd.,
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Od 3383

Invincible Gauge Glasses.
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and
ENGINEERING WORKS,
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Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
The Scottish Tube Co., Ltd.
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement, page 33 & 44, Jan. 2.

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 2276

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Worm Wheels cut up to 13 ft. diam.
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OIL FUEL APPLIANCES,
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PRESSURE AIR, STEAM
For Boilers of all types.
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Naval Outfits a Speciality,
also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
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CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1948

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AND PROPULSION PROBLEMS
Special designs only.
"Circulation Theory."
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GENERATING SETS, Totally Enclosed, Three Crank Self-Lubricating Engine, with Complete Condensing Plant, by Allens, Pipes, Valves, Oil Separator, Etc., complete.
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Tubes AND Fittings
AND
Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW BIRMINGHAM LONDON.
See Advertisement, page 81. 2584

Peter Brotherhood Ltd.,
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 49, Jan. 2.

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Undertake SPECIAL MACHINE WORK of any description.
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In gauges from 8—18 and sizes up to 40 by 20 in.
Guaranteed flat, of Uniform thickness, and Highly Polished.
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306, High Holborn, London, W.C.1. 585
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SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

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LAND AND MARINE
YARROW BOILERS.
2277

Matthew Paul & Co., Ltd., 2212
LEVENFORD WORKS, Dumbarton.
See Full Page Advt., page 53, Jan. 2.

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Walter Somers, Limited,
HALESOWEN. 7116

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works and Showrooms: BIRMINGHAM.
See Advert., page 57, Jan. 2. 8196

Railway Switches and Crossings.
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DARLINGTON. 2008

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For Paraffin and Crude Oil
Sizes 1½ B.HP. and upwards.
Petters Limited, Yeovil.
Sizes 25 to 500 B.HP.
Vickers-Petters, Ltd., Ipswich
See advertisement alternate weeks. 9335

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STATIONARY DIESEL ENGINES with accessories, as delivered from the makers under Peace Treaty; also Dynamos for same. All spare parts in stock.—HICK-DIESEL OIL ENGINES LTD., 70, Queen Victoria Street, E.C. 4. 2521
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Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers,
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To plane 16 ft. by 5 ft. by 5 ft.
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Special Courses of Evening Lectures will be given during January, February and March.

Furnaces and the Utilisation of Fuel—Professor J. W. COBB, C.B.E., B.Sc., F.I.C.

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The Laboratory will be open on Wednesday evenings during January and February for students desiring instruction in Fuel Calorimetry and Pyrometry and for more advanced students capable of independent work.

Further information may be had from THE REGISTRAR, The University of Leeds. G 821

Correspondence Courses for

Inst. Civil Engrs., Inst.Mech.E., London Univ. (Matric., Inter., B.Sc.), Inst.M. & Cy.E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc.M.Inst.C.E., Chartered Civil Engineer. M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition. — For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1993

Draughtsmen, before

Negotiating with Government Departments in connection with any post, please communicate with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's Square, London, S.W.1. G 758

TENDERS.

BENGAL-NAGPUR RAILWAY COMPANY, LIMITED

The Directors are prepared to receive

Tenders for :—

10 LOCOMOTIVE BOILERS.

Specification and Form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad Street, E.C.2, on or after 7th January, 1925.

A fee of 20s. will be charged for the Specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Tuesday, 20th January, 1925.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
Secretary. G 846

HEATING.

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, etc., are prepared to receive

Tenders before Eleven

a.m., on Tuesday, 27th Jan. 1925, for the INSTALLATION of ACCELERATED LOW PRESSURE HOT WATER HEATING at the Central Telephone Exchange, Sheffield.

Drawings, Specification, a copy of the conditions and Form of Contract, Bills of Quantities and Forms for Tender may be obtained from the Contracts Branch, H.M. Office of Works, King Charles Street, London, S.W.1, on payment of One Guinea. (Cheques payable to THE COMMISSIONERS OF H.M. WORKS, etc.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. G 823

ROYAL STATE RAILWAYS OF SIAM.

NOTICE.

Sealed Tenders for the Supply

of SUPERSTRUCTURES of STEEL RAILWAY BRIDGES, B.E. 2468, will be received by the Administration of the Royal State Railways of Siam, Bangkok, until Fourteen o'clock on the 15th day of May, 1925, at which place and hour the Tenders will be publicly opened and read.

Blank Tender Forms, General Conditions, Specifications and Drawings may be obtained from Messrs. C. P. SANDBERG, 40, Grosvenor Gardens, London, S.W.1, upon payment of £1 10s. per set, which sum will not be refunded.

Right is reserved to reject any or all Tenders and to accept any Tender which is to the best interests of the Royal State Railways of Siam.

(Signed) PURACHATRA,
Commissioner-General,
Royal State Railways of Siam. G 838

ROYAL STATE RAILWAYS OF SIAM.

NOTICE.

Sealed Tenders for the Supply

of STEEL RAILS and PERMANENT WAY ACCESSORIES, B.E. 2468, will be received by the Administration of the Royal State Railways of Siam, Bangkok, until Fourteen o'clock on 1st May, 1925, at which place and hour the Tenders will be publicly opened and read.

Tender Forms, etc., may be obtained from Messrs. C. P. SANDBERG, 40, Grosvenor Gardens, London, S.W.1, upon payment of £1 10s. per set, which sum will not be refunded.

Right is reserved to reject any or all Tenders and to accept any Tender, which is to the best interest of the Royal State Railways.

(Signed) PURACHATRA,
Commissioner-General,
Royal State Railways of Siam. G 839

The Director-General,

INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES

1. WHEELS AND AXLES for Goods Wagons.
2. LOCOMOTIVE WHEEL LATHES.
3. WOOD SCREWS, NAILS, etc.
4. BOGIE CARRIAGE UNDERFRAMES.

Tenders due on the 20th January, 1925, for No. 1; on the 23rd January, 1925, for Nos. 2 and 3; and on the 17th February, 1925, for No. 4.

Tender Forms obtainable from above. G 862

LONDON & NORTH EASTERN RAILWAY.

The Directors are prepared to receive

Tenders for the Supply of

STEELWORK for the renewal of Bassington Road and Holderness Drain Bridges. The Contract comprises about 49 tons of steel troughs and decking, riveted up, painted, etc., but not erected.

Drawings and Specification may be seen, and detailed quantities and Forms of Tender obtained, on personal application at the Office of the Engineer, North Eastern Area, York. Sealed Tenders, marked "Tender for Bassington Road and Holderness Drain Bridges," must be received by the Joint Secretaries, L.N.E. Railway, Marylebone Station, London, N.W.1, by Nine a.m., Monday, 19th January, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

JAMES McLAREN,
G. F. THURSTON,
Joint Secretaries.

Secretary's Office,
Marylebone Station, N.W.1.
31st December, 1924. G 836

LIVERPOOL CORPORATION ELECTRIC SUPPLY DEPARTMENT. PLANT FOR SALE.

The CORPORATION OF LIVERPOOL invite

Offers for the Purchase and

REMOVAL of FIVE 200 K.W. MOTOR GENERATORS, now lying at the Pumpfields Station, Vauxhall Road, Liverpool.

Each Motor Generator consists of an A.C. 6000 volts, 3-phase 50 period Squirrel Cage Motor, and a D.C. 470/525 volt Generator.

The full load speed of the machines is 420 r.p.m. and output 400 amperes at 500 volts. The machines are in thorough working order, and have been removed to make room for larger plant.

The machines may be inspected by arrangement with the City Electrical Engineer, 24, Hatton Garden, Liverpool, from whom further particulars may be obtained.

Offers should be delivered to the City Electrical Engineer not later than 16th January, 1925, and endorsed "Offer for Electric Plant."

The Corporation do not bind themselves to accept the highest or any offer.

WALTER MOON,
Town Clerk. G 774

ARMY CONTRACTS.

TENDERS FOR MANUFACTURED GOODS.

Notice is hereby given that

Tenders for Specified

quantities of the undermentioned MANUFACTURED GOODS are Invited from time to time as required:—

METAL TRADES, etc.:—
Aluminium castings and pressings, Bedsteads, Cutlery, Copperware, Enamelled Ware, Fencing (woven wire and strained iron wire), Field Forges, Hollow-ware, Lamps and Lanterns, Nails, Saddletrees, Sash Chains, Scratch Card, Screws, Shovels, Stoves, Grates, etc., Telegraph Poles (Iron), Tinplates, Tinware, Tools, Tubing, Wire.

TEXTILE TRADES, etc.:—
Blankets, Braids, Buckram, Canvas and Canvas Goods, Cloth, Cordage, Cottons and Cotton Goods, Cotton Waste, Embroidery, Flags, Flannel, Headdresses, Horse Rugs, Hosiery, Linens and Linen Goods, Sewing Cotton and Thread, Silk, Sponge Cloths, Tapes, Tents, Webs.

ELECTRICAL and SCIENTIFIC INSTRUMENT TRADES:—
Cables, Electrical Stores, Scientific Instruments.

GENERAL TRADES:—
Boots and Shoes, Boxes and Chests, Brushes and Brooms, Candles, Chemicals (including Acetone, Alcohol, Aluminium Powder, Anhydrous Ammonia, Barium Nitrate, Magnesium Powder, Soda), Chinaware, Combs, Cooperage, Earthenware, Furniture, Glassware, India-Rubber Goods, Leather Goods, Paint (including paint, zinc oxide, dry), Soap, Stable fitments, Timber, Vehicles Woodware.

Manufacturers who are not already on any War, Office List of tenderers and who may wish to be invited to tender for Army requirements of the above stores should apply to the Director of Army Contracts, at the address given below, for Form 1, on which formal application for inclusion on the list of tenderers may be made. The services of an intermediary are unnecessary in approaching the Department for this purpose.

Before being placed on the lists of tenderers, firms will have to satisfy the Department that they actually manufacture the goods for which they wish to be noted and will be required to furnish the names of at least two well-known firms or public bodies who have purchased from them and are in a position to certify as to the quality of their productions and also to satisfy the Department that their financial position is adequate. They will further have to give an undertaking that they will comply with the Fair Wages Resolution of the House of Commons.

Attention is called to the decision of His Majesty's Government that, "save in very exceptional circumstances, all firms contracting for Government Contracts to whom the conditions of membership of the King's Roll are applicable, must be on the King's Roll."

SALES. From time to time the Department has for sale surplus army stores of various descriptions, among which may be mentioned Mechanical Transport, Drugs, Medical and Dental Stores, Veterinary Stores, Laboratory Apparatus. Firms who wish to be invited to tender for the purchase of surplus stores should apply as directed below.

All applications should be in writing and should be addressed to the Director of Army Contracts, Caxton House (West), Tothill Street, Westminster, London, S.W. 1. No application is necessary from firms whose names are already on the War Office lists.

DIRECTOR OF ARMY CONTRACTS G 866

BOMBAY, BARODA AND CENTRAL INDIA RAILWAY CO.

The Directors are prepared to receive up to Noon on Wednesday, 21st January,

Tenders for the Supply of :—

PIG IRON (WEST COAST HEMATITE).

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 10s each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Offices: 91, Petty France, Secretary.
Westminster, S.W. 1.
7th January, 1925. G 876

METROPOLITAN ASYLUMS BOARD.

TO ELECTRICAL ENGINEERS.

The Board invite

Tenders for the Installation

of ELECTRIC LIGHTING, POWER, TELEPHONES, FIRE ALARM and DOMESTIC BELLS in the three new ward blocks at Tooting Bec Hospital, Tooting, S.W.17, in accordance with the Specification and Drawings prepared by Mr. T. COOPER, M.Inst.C.E., M.I.Mec.E., Engineer-in-Chief. The Specification, Drawings, and Form of Tender may be inspected at the Office of the Board, Victoria Embankment, E.C.4, on and after Ten a.m. on Monday, 12th January, 1925, and can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a *bona fide* Tender sent in accordance with the instructions on the Form of Tender and after the Specification and the Drawings have been returned.

Tenders addressed as noted on the Form must be delivered at the Office of the Board not later than 2.30 p.m. on Wednesday, 28th January, 1925.

G. A. POWELL,
Clerk to the Board. G 859

SOUTHAMPTON CORPORATION WATER-WORKS.

OTTERBOURNE PUMPING STATION.

TO PUMPING ENGINE MANUFACTURERS.

The Corporation invite

Tenders for the Manufacture,

DELIVERY, ERECTION, SETTING TO WORK, TESTING and MAINTAINING for a period of six (6) months of 2 TRIPLE EXPANSION PUMPING ENGINES, WELL and FORCE PUMPS, etc., each set to be of a capacity of 6 million gallons per day of 24 hours, against a head of 280 feet.

Plan of Existing and Proposed Engine Houses, etc., with Specification, Conditions of Contract and Form of Tender, may be obtained from Mr. E. C. RODDA, Waterworks Engineer, 21, Shirley Road, Southampton, upon production of the Borough Treasurer's receipt for a deposit of £5 5s.

Deposits will be returned after the Council have dealt with the Tenders to Contractors who have submitted *bona fide* Tenders.

Sealed Tenders endorsed "Tender for Pumping Plant, Otterbourne Waterworks," must be delivered at the Town Clerk's Office, on or before the 16th February, 1925.

No pledge is given to accept the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.
6th January, 1925. G 852

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED,

are prepared to receive

Tenders for the Supply of :—

WATER CRANES.

Specifications and Forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked: "Tender for Water Cranes," must be left with the undersigned not later than Twelve Noon on Friday, the 23rd January, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of the Specification.

Copies of the Drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. ROBERT WHITE & PARTNERS, of 3, Victoria Street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1.
6th January, 1925. G 865

METROPOLITAN ASYLUMS BOARD.

TO HEATING ENGINEERS AND OTHERS.

The Board invite

Tenders for the Installation

of HEATING APPARATUS in the Central Hall, at the Downs Hospital for Children, Banstead Road, Sutton, Surrey, in accordance with the Specification and Drawings prepared by Mr. T. COOPER, M.Inst.C.E., M.I.Mech.E., Engineer-in-Chief. The Specification, Drawings, and Form of Tender may be inspected at the Office of the Board, Victoria Embankment, E.C.4, on and after Ten a.m. on Monday, 12th January, and can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a *bona fide* Tender sent in accordance with the instructions on the Form of Tender, and after the Specification and the Drawings have been returned.

Tenders, addressed as noted on the Form, must be delivered at the Office of the Board, not later than 2.30 p.m. on Wednesday, 28th January, 1925.

G. A. POWELL, G 873
Clerk to the Board.

APPOINTMENTS OPEN.

DERBY TECHNICAL COLLEGE.

An Assistant Lecturer in

Engineering Science, with Mathematics, is REQUIRED Immediately. Salary according to Burnham Scale, less usual abatements. Forms of application may be obtained from the PRINCIPAL. G 867

Wanted, Man with know-

ledge of Physics, Mechanics, Chemistry, Mathematics and Drawing to teach scientific principles of Boot and Shoe Manufacture. Salary, Burnham Scale.—Apply not later than January 17th, by letter, with fullest particulars, stating workshop practice (if any) to, CORDWAINERS' TECHNICAL COLLEGE, St. John's Lane, E.C.1. G 845

Applications are Invited for

the POSITION of WORKS MANAGER by an old established Company in the North of England, manufacturing Steam Turbines, Condensing Plants, High-Speed Steam Engines and Air Compressors. Candidates must be qualified Engineers, energetic and good organisers, capable of controlling men and supervising contracts to completion.—Address, stating age, experience and salary required, to G 841, Offices of ENGINEERING.

The National Omnibus and

TRANSPORT COMPANY LIMITED, REQUIRE an ASSISTANT WORKS MANAGER, age about 30-35, Manufacturing experience and good knowledge of body work, running repairs and maintenance of rolling stock essential.—Applications giving full particulars of experience and salary required to be addressed to the SECRETARY, 206, Brompton Road, S.W.3. Envelopes to be marked "A.W.M." G 804

Melting Shop Manager.—

THE CONSETT IRON CO., LTD., is about to APPOINT a MANAGER of its new Steel Works, and is therefore ready to receive applications from men of experience in Acid and Basic Steel Making.—Apply, SECRETARY, CONSETT IRON CO., LTD., Consett, Co. Durham, with full information as to previous experience, age, &c., &c. G 858

ADMINISTRATIVE COUNTY OF LONDON.

APPOINTMENT OF HYDRANT INSPECTOR IN THE LONDON FIRE BRIGADE.

The London County Council invites

Applications for Appointment

as HYDRANT INSPECTOR in the Department of the Chief Officer of the Fire Brigade.

The duties of the position will be to inspect and report on hydrant defects, and to supervise the work of fixing and repairing hydrants. Candidates must have had experience in the building or engineering trades. Preference will be given to applicants who have a practical knowledge of water main laying, brick-laying and fire hydrant work.

The rate of pay attaching to the position is based on pre-war conditions and is subject to temporary additions on the Civil Service scale, such additions being subject to increase or decrease according to the rise or fall in the cost of living. The commencing rate of pay is 55s. a week rising by 2s. 6d. annually to a maximum of 65s. a week. With the temporary additions above referred to the commencing total rate of remuneration will be 83s. 3d. a week. Candidates should be under 35 years of age Preference will be given to men who have served or attempted to serve with H.M. Forces during the Great War.

Particulars and forms of application may be obtained from the Clerk of the Council, County Hall, Westminster Bridge, S.E.1, and must be returned to him not later than Eleven a.m. on Monday, 26th January, 1925. Canvassing disqualifies.

An addressed foolscap envelope bearing 1½d. stamp must be sent with the request for the form of application.

JAMES BIRD, G 812
Clerk of the London County Council.

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ENGINEER is REQUIRED to take charge of one section of a large Designing Office. Technical ability, wide experience and personality essential—Address, in confidence, stating age, salary required, and give a brief summary of experience in the first instance, G 817, Offices of ENGINEERING.

Resident Engineer Required

for new sea defence works and buildings. Must have had similar experience, and possess sound knowledge of handling and working of large plant; competent to set out works, take levels, make surveys, supervise Contractor's work, check quantities, make detail drawings, prepare specifications, and supervise and control labour. Thorough understanding of good work essential. Salary £7 7s. per week. State age, qualifications and experience, with testimonials.—Address, G 830, Offices of ENGINEERING.

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petent ENGINEER having extensive experience in the design of large Valves, Sluice Gates, etc., for Hydro-Electric & Irrigation Works, etc. The duties would include supervising designs, preparing estimates, conducting correspondence, interviewing clients when necessary, and generally controlling the technical and commercial side of the department in a large and old established concern specialising in this class of work. Only first-class men possessing the necessary qualifications will be considered. Applicants should state age, experience and salary required.—Address, G 804, Offices of ENGINEERING.

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THE FORMATION OF WAVES.

By J. O. V. IRMINGER.

I PUBLISHED in the Danish paper *Ingeniören* in April and May, 1894, an article on "Windpressure on Buildings and other Structures." My observations formed the subject of articles which later on were published in ENGINEERING, December 27, 1895, and in *Engineering News*, February 14, 1895. In these articles were set forth the results of experiments made with models exposed to an artificial wind. One of the experiments had for its object to find out the effect of the wind on an ordinary roof, and it was found that a pressure existed on the windward-side, decreasing to zero near the ridge, a strong suction taking place at the same time over the whole leeward-side of the roof. The correctness of the results obtained in these experiments has since been proved by other observers.

Mr. Fr. Johannsen, Managing Director of the Telephone Company of Copenhagen, has taken a great interest in these matters, and stated some years ago that in his opinion somewhat similar considerations to those mentioned above in connection with roofs might also apply to the formation of waves, and he asked me to make some experiments in this connection. As far as I am aware similar experiments have not been carried out before, and I therefore think that the publication of my results may be of some interest.

The method employed in these experiments was the same as that used in 1894. A chimney of about 30 meters in height giving a strong and even draft was used to produce the air current. Near the bottom of the chimney was fitted a horizontal channel made of wood 125 cm. long, 23 cm. high and 12 cm. wide inside. The mean suction in the (centre) of the channel was 8·74 mm. of water gauge and the velocity of the wind about 13 m. per second, which was measured by an anemometer with the model in place inside the channel. The models used were made of tin plate and the sections used are shown in Figs. 1 to 4, annexed. The width of each model was 12 cm. and during the experiment the model was fixed airtight to a wooden plate in such a way as to leave a hollow space between the model and its support. Each of the four models were three wavelengths long, and the observations were made on the middle wave. A similar orifice was fitted in the upper part of the channel above the middle wave, and the pressures recorded below are the differences between the pressure at this orifice and those at the surface of the wave. The pressure distribution over this was measured by tubes connecting orifices in the models with a sensitive pressure gauge.

Typical observations are recorded in Table I.

TABLE I.

Hole.	Model No.			
	I.	II.	III.	IV.
1	−1·13	+0·88	+1·83	−1·80
2	−0·50	+0·75	+1·25	−1·30
3	−0·25	−0·15	—	+0·95
4	−0·67	−3·67	−0·97	−0·85
5	−0·75	−0·90	−5·73	−1·27
6	−0·25	+0·25	+0·65	−1·40
7	−0·25	+1·00	+2·25	−1·50
8	−0·55	+0·50	+0·95	—

For the purpose of ascertaining the "normal pressure," a vertical plane of the size of the cross section of the model was inserted, and pressures and suctions on the said plane were determined after the model had been removed.

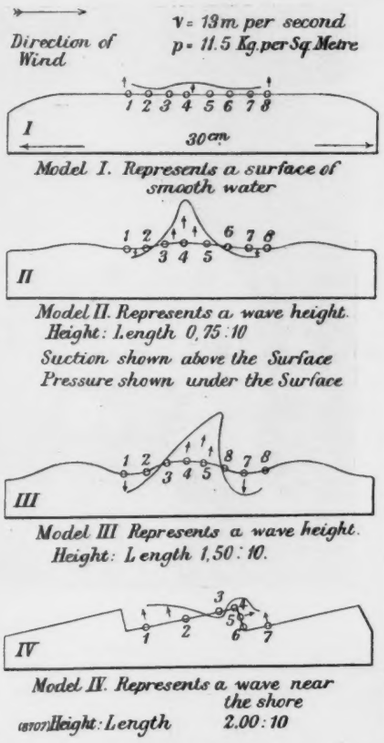
The mean pressure on the windward side was 6·43 mm. (pressure) and 5·07 mm. (suction) on the leeward-side. The total pressure was 11·5 mm. equal to 11·5 kg. per $m^2 = p$. This corresponds to a velocity of 13 m. per second of the wind according to the formula of G. Eiffel, which is in conformity with direct measurements.

For the sake of clearness the observations in Table I have also been computed in terms of p and the results are set forth in Table II and have been plotted in Figs. 1 to 4. As there shown, it will be seen that a small suction of about 0·04 p exists along the whole surface of model 1. With the second model there was a maximum suction of 0·32 p on the top of the wave, which decreased to zero near the centre of the wave and then changed to a positive pressure with maximum 0·08 p at the bottom of the wave. The total suction integrated over the whole wave length is about 1·7 of the total pressure.

TABLE II.

Hole:	Model No.			
	I.	II.	III.	IV.
1	−0·098 p	+0·077 p	+0·159 p	−0·157 p
2	−0·043 ,,	+0·065 ,,	+0·109 ,,	−0·113 ,,
3	−0·022 ,,	−0·013 ,,	—	+0·083 ,,
4	−0·058 ,,	−0·319 ,,	−0·084 ,,	−0·074 ,,
5	−0·065 ,,	−0·078 ,,	−0·498 ,,	−0·110 ,,
6	−0·022 ,,	+0·022 ,,	+0·057 ,,	−0·122 ,,
7	−0·022 ,,	+0·087 ,,	+0·196 ,,	−0·130 ,,
8	−0·048 ,,	+0·043 ,,	+0·083 ,,	—

Model III shows a maximum suction of 0·5 p somewhat to the leeward side of the wave crest.


Direction of Wind
V = 13m per second
p = 11.5 Kg per Sq Metre
1 2 3 4 5 6 7 8
I
30cm
Model I. Represents a surface of smooth water
1 2 3 4 5 6 7 8
II
Model II. Represents a wave height. Height: Length 0,75 : 10
Suction shown above the Surface
Pressure shown under the Surface
1 2 3 4 5 8 7 8
III
Model III Represents a wave height. Height: Length 1,50 : 10.
1 2 3 4 5 6 7
IV
Model IV. Represents a wave near the shore
Height: Length 2.00 : 10

The maximum pressure in the bottom of the wave is 0·16 p to 0·19 p and the integrated suction is again about 1·7 of the pressure.

In both these cases a considerable suction appears to exist at the top of the wave, whilst a pressure exists at the bottom of the wave. In view of the fact that these influences are present continuously as long as the strength of the wind remains constant, the tendency will be for the waves to increase more and more until an equilibrium is reached corresponding to the strength of the wind. The strong suction on the top of the wave will tend to sharpen the wave crest, and the wave will loose its smooth surface.

Model IV is of a form corresponding more or less to a breaking wave in shallow water. The pressure and the suction here change places, a small maximum pressure of 0·08 p being obtained on the top of the wave crest slightly to the windward side, and a maximum suction of 0·13 to 0·15 on the remaining part; there will, in other words, be a tendency to level the wave.

The experiments described above do not, of course, pretend to be very exact, but they may possibly induce an aeronautic research station to take up the matter for further investigation. If it be admitted that the increase of the waves, once wave formation has commenced, is due to the influences described above, the next question will be: how is the formation of the wave initiated when the surface is completely at rest?

The wind will, when moving along a surface produce a suction proportional to the wind pressure p, or to v^2, which fact can also be proved by experiments easily carried out. The velocity of the wind varies incessantly in the same place, and for this reason the suction will lift the water particles upwards in places where the wind is strong, whilst the movement will be less pronounced where the velocity of the wind is smaller the result being that the equilibrium is disturbed. The movement of the water particles is no doubt very slight to begin with, but even such a small movement represents a wave on a small scale, and if the wind continues to blow large waves will be formed as mentioned above.

VIBRATION OF STEAM TURBINE DISCS.

By Dr. J. von FREUDENREICH.

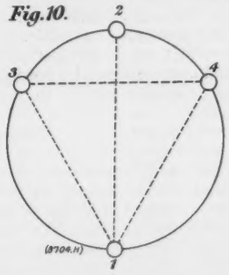
(*Concluded from page* 4.)

DYNAMIC TESTS.

WHILST static tests can be carried out quite easily, dynamic tests with bladed discs present far greater difficulties. Messrs. Brown Boveri & Co., Limited, with the aid of their large over-speed testing plant, were able to carry out such tests on bladed discs of 1,500 mm. diameter and up to 4,000 r.p.m. These tests are extremely interesting and hence will be considered in some detail.

The disc is mounted on an overhung horizontal shaft, which is driven through gearing by means of a motor. In order to reproduce as closely as possible the effect of partial admission four D.C. magnets are placed at the circumference of the disc. The position of the magnets is given in Fig.10. The magnets 1 and 2 lie diametrically opposite to one another whilst 1, 3 and 4 form an isosceles triangle.

Fig.10.



In order to produce each number of nodal diameters, it was, as a rule, only necessary to excite one magnet. Only when a disc happened to vibrate about 2 or 3 diameters at the same speed was it necessary to excite magnets 1 and 2 for vibrations about 2 nodal diameters and magnets 1, 3 and 4 for vibration about 3 diameters. Once a certain type of vibration was produced one magnet was sufficient to maintain it. If several magnets were excited the rim of the disc was liable to become very hot owing to eddy currents, in fact in some instances the temperature of the rim reached 170 deg. C., in spite of the rapid cooling of such a disc rotating in a cold atmosphere. This heating of the rim allowed the influence of the unequal distribution of temperature on the frequency of the vibrations to be observed.

The deflection remains fixed in space, and can be measured by an indicator fixed to an arm which can be rotated (Fig. 11). A hardened steel pin, pressed lightly against the rim of the disc by a fine spring, transmits the deflection of the disc to a pencil which reproduces the motion on an indicator drum, the latter being rotated from the motion of the arm through a train of gears.

In Fig. 12 some of the diagrams so obtained are reproduced on a reduced scale; the position of the magnets is indicated by the letter M. The measured revolutions per minute are also given on the

diagrams, and, if they are multiplied by the corresponding number of nodal diameters, the natural frequencies N of the vibrations are obtained, and hence the "dynamic characteristic" (curve 3, Fig. 2). Fig. 2 shows the results obtained for a thin and Fig. 13 those for a stiff disc.

Further, the growth and decay of the vibrations were also studied. For this purpose the disc was run up to the resonance point and the magnets suddenly cut out or switched in. The arm was kept at rest and the indicator drum slowly rotated by hand. In this manner curves such as are shown in Fig. 14 were obtained. As will be seen from the figure, the vibration decays in about 10 secs., and it takes approximately the same time to grow. This suggests the possibility of being able to detect vibrations while the turbine is actually running. A small feeler, which can be operated from the outside of the turbine casing, is constructed so that it can be made to bear lightly against the rim of the wheel; the deflection of the disc may then be measured, and if the feeler vibrates when the turbine is suddenly shut down, then it is quite certain that the disc had been vibrating.

From Fig. 15 it is quite clear that when the speed is approaching the resonance point, the vibration slowly grows and as the speed passes beyond this point the vibration slowly decays. In this case we have resonance at 2,550 r.p.m., and the phase displacement is 90 deg. It is, therefore, possible in this manner to solve experimentally the problem of disc vibration. It is clear that it may only be stated with absolute certainty that a disc will not vibrate about nodal diameters when the "dynamic characteristic" lies above the "straight line of excitation," as, for example, is the case in Fig. 13. In this instance, there is no intersection of the two curves, hence vibrations about nodal diameters at the given speed are quite impossible.

Naturally such tests as the foregoing are very expensive and require special apparatus. It will be shown later that it is possible to carry out these tests on small-scale model discs. On account of the great loss of power due to windage, when the discs to be tested are fitted with very long blades, such a small-scale model test is particularly desirable. The theoretical calculations of Professor Stodola indicate how to apply the results of such tests on model discs to actual practice. The main formulæ only are given here; for the complete theory the reader is referred to the sixth edition of "Dampf- und Gasturbinen."

Method of Calculation due to Professor Stodola.

The method of calculation due to Professor Stodola is based on Rayleigh's theory, which states that, of all the possible forms of deformation which may occur in a given elastic body, the one which will actually exist will be that which corresponds to the smallest frequency of vibration. The frequency for a certain assumed deformation may be calculated by considering the state of the vibrating disc (1) when at the point of maximum deflection and (2) when in the plane of rest. In the first case the disc possesses only potential energy, and in the second, when it is passing through the plane of rest, the energy is entirely kinetic. By equating these energies an equation is obtained from which the frequency of vibration may be found.

The potential energy is the sum of the resilience Φ_i and of the energy due to the centrifugal forces Φ_z arising from the rotation of the disc. If, then, Φ_K is the total kinetic energy, we have

$$\Phi_i + \Phi_z = \Phi_K \quad . \quad . \quad . \quad (1)$$

For the deflection w of the disc the following equation may be chosen:

$$w = \eta \cdot \sin(\lambda t) \quad . \quad . \quad . \quad . \quad (2)$$

where

$$\eta = f(r) \cdot \cos(k\phi)$$

k being the number of nodal diameters. For the kinetic energy we then obtain—

$$\Phi_K = \Sigma \frac{m}{2}\left(\frac{\partial w}{\partial t}\right)^2 = \lambda^2 \Sigma \frac{m}{2} \cdot \eta^2 = \lambda^2 \cdot K_0$$

where K_0 is a function only of the dimensions of the disc and of the assumed deformation. Substituting this value in equation 1, we have for a disc at rest:

$$\left.\begin{aligned} \lambda^2_{st} &= \frac{\Phi_i}{K_0} \\ \text{and for a rotating disc} \\ \lambda^2_{dyn} &= \frac{\Phi_i + \Phi_z}{K_0} = \lambda^2_{st} + \lambda^2_t \end{aligned}\right\} \quad . \quad . \quad (3)$$

The centrifugal force term λ_t is for a rotating disc with the same distribution of mass but without resistance to bending.

For a given disc of radius R, minimum thickness h_0, and maximum deflection γ_0 we can obtain the following expressions:

$$\left.\begin{aligned} \Phi &= \frac{E^1 h_0^5}{R^2} \cdot y^2_0 \cdot C_i \\ \Phi_z &= \mu \omega^2 R^2 h_0 y^2_0 \cdot C_z \\ K_0 &= \mu R^2 h_0 y^2_0 \cdot C_K \end{aligned}\right\} \quad . \quad . \quad (4)$$

The terms C_i, C_z and C_K are without dimensions and depend only on the ratios h/h_0 and r/R of the disc, and on the number of nodal diameters. They remain, therefore, constant if the disc is built to another scale. From the above equations we obtain

$$\left.\begin{aligned} \lambda^2_{st} &= \frac{\Phi_i}{K_0} = \frac{E^1 h^2_0}{\mu R^4}\left[\frac{C_i}{C_K}\right] \\ \lambda^2_{dyn} &= \frac{\Phi_i + \Phi_z}{K_0} = \frac{E^1 h^2_0}{\mu R^4}\left[\frac{C_i}{C_K}\right] + \omega^2\left[\frac{C_z}{C_K}\right] \end{aligned}\right\} \quad (5)$$

The ratio h_0/R^2 is a measure of the "slimness" of the disc. The more slender the disc the greater will be the importance of the centrifugal-force term; for stiff discs the influence of this term decreases considerably.

We will now consider a given disc and at the same time an exact model of it built to a scale m. Let the given disc have the dimensions h_0 and R and the model $h^1_0 = m h_0$ and $R^1 = m R$. It follows, then, from equation 5 that

$$\lambda^1_{st} = \frac{1}{m}\lambda_{st} \quad . \quad . \quad . \quad (6)$$

i.e., the static frequencies of the vibrations are inversely proportional to the dimensions of the disc.

For the rotating disc we have:

$$\left.\begin{aligned} \lambda^2_{dyn} &= \lambda^2_{st} + \omega^2\left[\frac{C_z}{C_K}\right] \\ \lambda_1{}^2_{dyn} &= \frac{\lambda^2_{st}}{m^2} + \omega_1{}^2\left[\frac{C_z}{C_K}\right] \end{aligned}\right\} \quad . \quad . \quad (7)$$

If we choose ω_1 so that the model rotates with the same peripheral velocity as the full-size disc, then:

$$\omega_1 = \frac{\omega}{m}$$

and

$$\lambda^1_{dyn} = \frac{1}{m}\lambda_{dyn} \quad . \quad . \quad . \quad (8)$$

that is to say, that with the same peripheral velocities the dynamic frequencies of the vibrations are also inversely proportional to the dimensions of the disc.

By means of tests, therefore, the "static" and "dynamic" characteristics of a small-scale model can be determined, and then from formula 7 the frequencies of the vibrations of the full-size disc may be calculated.

The effect of an unequal distribution of temperature was also theoretically treated by Professor Stodola. It appears that the effect may be calculated in just the same way as the influence of the centrifugal forces is determined, the only difference being that the centrifugal stresses are replaced by those due to the unequal heat distribution. Professor Stodola came to the following conclusion: that if the temperature difference t_0 between the hub and the rim is continually increased, a point will eventually be reached at which the disc will fail. This temperature difference is the critical temperature difference t_{ok}. For each number of nodal diameters there will be a different critical temperature difference, as is shown in Fig. 16. For 0 and 1 nodal diameters the critical temperature difference is, as already mentioned, negative; that means to say, a heating of the rim of the disc increases the natural frequency of vibration.

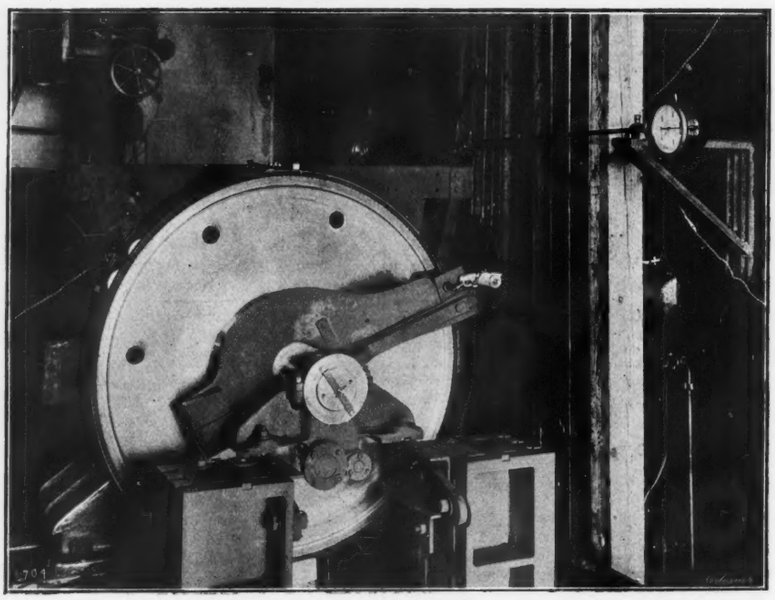


Fig. 11.

The frequency of vibration of a warm disc can be calculated from the equation—

$$\lambda^2_w = \frac{\Phi_i + \Phi_z + \Phi_t}{K_0} \quad . \quad . \quad . \quad (9)$$

where Φ_t is the energy due to the heat stresses when the disc is in the position of max. deflection.

$$\Phi_z = -\, y_0{}^2 t_0 \Theta.$$

Where Θ depends only on the dimensions and deformation of the disc and on the heat stresses.

As $\Phi_i = B \cdot y_0{}^2$ and $\Phi_z = C\omega^2 y_0{}^2$ (see equations 4) then the right-hand side of equation 9 becomes zero when

$$B + C\omega^2 = \Theta \cdot t_{ok}$$

Hence the critical temperature difference t_{ok}

$$t_{ok} = \frac{B + C\omega^2}{\Theta}$$

The critical temperature differences plotted in Fig. 16 have been calculated from the above equation.

For the cold disc we have—

$$\lambda^2_K = \frac{\Phi_i + \Phi_z}{K_0}$$

hence

$$\lambda_w^2 = \lambda_K^2 - \frac{y_0^2\, t_0\, \Theta}{K_0} = \lambda_K^2 \left(1 - \frac{t_0}{t_{0k}}\right)$$

or

$$\lambda_w = \lambda_k \sqrt{\frac{t_{0k} - t_0}{t_{0k}}} \quad . \quad . \quad . \quad (11)$$

This extraordinary simple equation enables the frequency of vibration to be determined as a function of the temperature difference between the rim and hub. Of course, for this calculation a certain radial distribution of temperature between the hub and rim must be assumed, the critical temperature being a function of this temperature gradient for any given temperature difference between the hub and rim. In all practical cases, however, the approximate distribution of temperature is known; hence the above formula may be used without appreciable error.

If we compare the speed at which we have resonance for a cold disc with that for a hot one, we have in this case the equation:

$$\lambda_w = \lambda_K \sqrt{\frac{t_{0k} - t_0}{t_{0k}}}$$

where t_{0k} is the static and not the dynamic critical temperature.

The critical temperature differences of two similar discs are to one another as their ratios h_0^2/R^2.

Comparison between the Theory and the Test Results.

In Table I, below, we give the calculated and measured frequencies for a slender disc.

With regard to these figures it may be mentioned that for the umbrella type of vibration (zero nodal diameter) the theory assumes that the hub of the disc is fixed in such a manner that no movement axially is possible; in practice this is not the case, as the mass to which the hub is attached is not infinitely great, hence the comparatively large error. It should be noticed that for a warm disc it is almost impossible to measure accurately the temperature of the rim, especially at high speeds, on account of the rapid cooling due to windage, and the temperature drop along a radius of the disc is also unknown. In spite of these inaccuracies, there appears to be a remarkable agreement between the calculated and measured figures, and it therefore appears possible to calculate to within a close degree of accuracy the frequencies of vibration of a given disc.

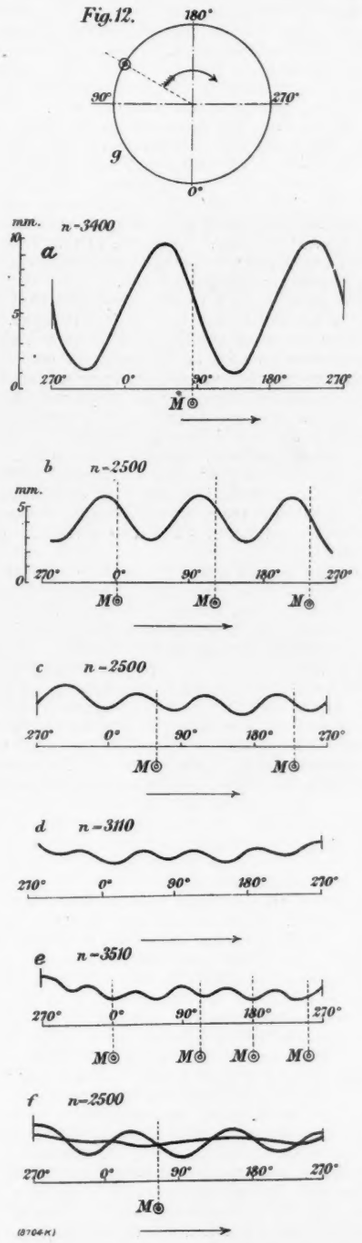
The same is also true for a stiff disc, for which the results given in Table II have been obtained.

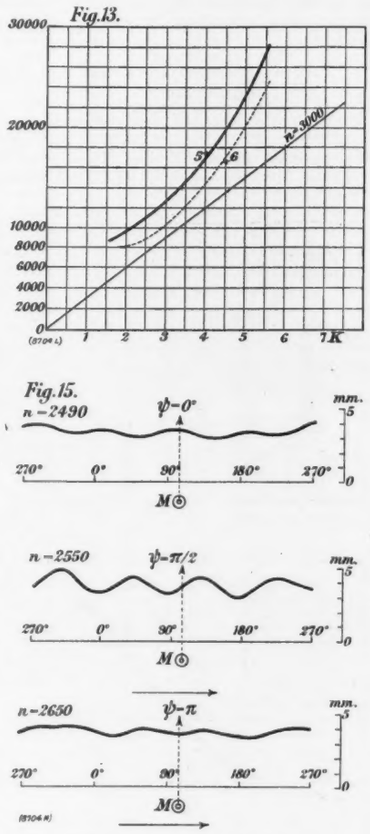
Here also the agreement is remarkably good, with the exception of the case of the umbrella type of vibration, where, as already mentioned, the test results are too high owing to the hub not being rigidly fixed. A thin disc 500 mm. diameter and of uniform thickness 2·5 mm., on which an air jet impinged (in place of a magnet) behaved in a remarkable manner. Up to almost 2,500 r.p.m. there was no deformation of the disc, then as the speed increased a standing wave of about 2 nodal diameters developed, and when the speed was further increased the deflection did not disappear, but increased only in amplitude and at 5,000 r.p.m. amounted to 5·5 mm. In order to obtain a vibration about 3 nodal diameters, it was first of all necessary to run the speed up to 3,000 r.p.m. before opening the air jet, then with a further increase of speed the disc continued to vibrate about 3 diameters but with a greater amplitude. This behaviour may be explained from a consideration of equation 5. For a thin disc running at a high speed the influence of the first term, which is dependent on the stiffness of the disc, is very small compared with that of the second, which involves the centrifugal stresses and approximately we have

$$\lambda_{dyn}^2 = \sim c \cdot \omega^2$$

and then the disc is in resonance at every speed above a certain limit.

Finally, tests were made in order to determine





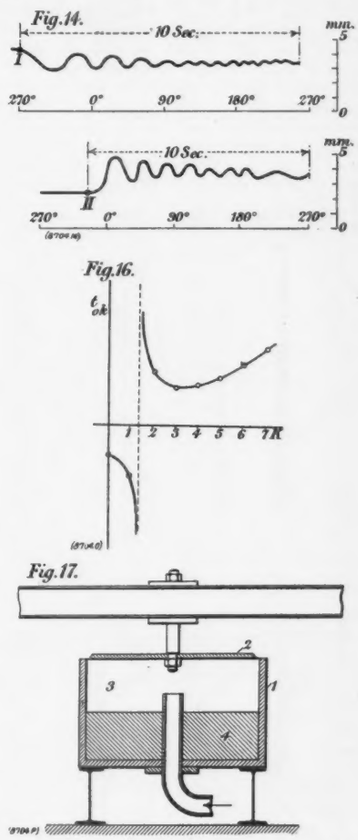


Table I.—*Slender Disc at Rest—Cold.*

No. of Nodal Diameters.	N/min Calculated.	N/min from test.	Error Per cent.
0	4,100	4,430	− 7·5
1	4,000	3,900	+ 2·5
2	4,490	4,670	− 3·9
3	6,435	6,600	− 2·5
4	10,450	10,090	+ 3·3
6	22,100	21,450	+ 3·0

Slender Disc Rotating—Warm.

No. of Nodal Diameters.	t_0 (°C).	N/min Calculated.	N/min from Test.	Error Per cent.
2	130	3,000	3,050	− 1·7
2	50	3,290	3,380	− 2·6
3	50	2,505	2,500	+ 0·2
6	130	3,800	3,510	+ 8·2

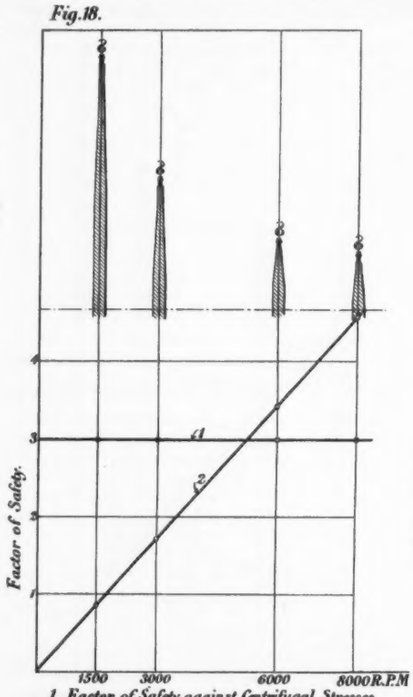
Table II.—*Stiff Disc at Rest—Cold.*

No. of Nodal Diameters.	N/min Calculated.	N/min from Test.	Error Per cent.
0	6,880	7,600	− 12·9
1	6,800	—	—
2	7,390	7,200	+ 2·7
3	9,870	10,300	− 4·2
4	14,470	14,700	− 1·6
5	20,800	20,850	− 0·2

whether a vibration can develop consequent upon the ejector action of the steam. Between the nozzles and the blades the steam jets suck steam from the surrounding space, and this, when the wheel is not provided with sufficient balancing holes, gives rise to a difference of pressure between the two sides of the disc, which results in a deflecting of the disc towards the nozzles, causing the ejector action to diminish, the difference of pressure then falls and the disc swings back into its original position, and the cycle of changes commences again. Even though the forces involved may be very small, they may still be dangerous if there is resonance.

These tests were carried out with the apparatus shown in Fig. 17. The opening of the vessel (1) was covered by the disc (2) in such a way that, with the disc at rest, the opening was a minimum. Air under pressure was then led into the vessel, the action of the air deflected the disc with a consequent increase in the area of the outlet from the vessel, thus the pressure of the air dropped and the disc swung back into its position of rest. The pressure then rose again, and so the vibration of the disc was maintained. The foregoing is in principle precisely the same as the ejector action of the steam in a turbine. It is quite obvious that the size of the space (3) is a very important factor. In order to vary the size of this space sand (4) was put into the vessel and rammed down.

Fig. 18.



1. Factor of Safety against Centrifugal Stresses.
2. Factor of Safety against Vibration.

(2704 g)

The disc was 985 mm. diameter and of uniform thickness 8 mm. As soon as air under pressure was led into the vessel the disc immediately commenced to vibrate. Of course, it was only possible to produce an umbrella type of vibration and not vibrations about nodal diameters. The following results were obtained :—

Volume (3) m³.	N/min.
0·27	1,760
0·165	2,910
0·13	2,140
0·07	2,300

The natural frequency of the vibration of the disc was measured and found to be N = 1,600. It was also calculated assuming a value for the deflection $\eta = y_0 X^s$ where the exponent s is to be varied according to the principle of Rayleigh. Thus we have $s = 2.2$ and $C_l/C_x = 3.32$.

From the formula

$$\lambda^2_{sl} = \frac{E^1 h_0^2}{\mu R^4}\left[\frac{C_l}{C_x}\right]$$

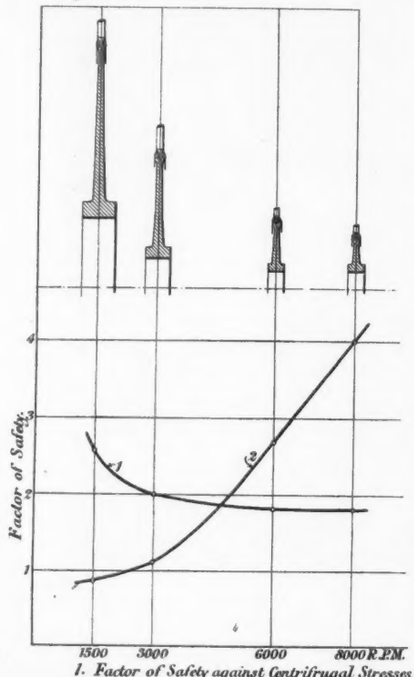
the natural frequency was found to be N = 1,580, which agrees very closely with the measured value, 1,600.

The table given above shows that the frequency of vibration of the system is dependent, among other factors, upon the volume of the vessel. The theory connected with the above form of vibration has also been developed by Professor Stodola. The problem will not be more closely considered, but attention may be drawn to the fact that the tests support his theory, and that the turbines built by Messrs. Brown, Boveri and Co., Limited, have a factor of safety of 20 against such vibrations.

The Factor of Safety for Stress and for Vibration.

In Fig. 18 four discs are shown, which are each equally stressed $\partial_r = \partial_t = 1{,}500$ kg./cm.² at a circumferential velocity of $u = 210$ m./sec., this corresponds to a factor of safety of 3 against failure due to centrifugal stresses. The factor of safety against vibration is proportional to the speed of rotation. In this particular case the factor of safety amounts to almost 5 at 8,000 r.p.m., whilst at 1,500 r.p.m. it is so low that freedom from vibration is not absolutely certain.

Fig. 19.



1. Factor of Safety against Centrifugal Stresses.
2. Factor of Safety against Vibration.

(2704 h)

In Fig. 19 the same curves for bladed discs with a hub are given. Here also at high speeds the factor of safety against vibration is large, whilst at low speeds the danger from vibration is very great, in spite of the fact that the factor of safety against centrifugal stresses is greater than at high speeds. In other words, in designing a disc to run at high speeds, it is sufficient to consider the centrifugal stresses only, the factor of safety against vibration of such a disc will then be so great that vibration is absolutely impossible. On the other hand, for large discs running at low speeds the factor of safety against vibration must certainly be determined.

Summary.—The exhaustive tests on the vibration of discs carried out at the works of Messrs. Brown, Boveri and Co., Limited, have been described, and the main formulæ quoted from the theory due to Professor Stodola. It appears that the whole problem of disc vibration may now be solved both theoretically as well as practically, and that discs may now be designed which will be quite free from vibration under all working conditions.

LITERATURE.

Colliery Electrical Engineering. By G. M. HARVEY, M.Sc., A.M.I.E.E. London: Sir Isaac Pitman & Sons, Limited. [Price, 15*s.* net].

DESPITE the increase in the number of sources of power, most countries in the world are almost entirely dependent on coal as a primary agent, and this condition is likely to endure for some considerable time. A state of affairs has now been reached when the utmost possible efficiency in methods of obtaining coal is essential. The highest efficiency can only be attained by the utilisation of the best possible means. Coal-mining, from the dangerous nature of the work involved, demands an agent at once reliable, flexible and safe, to an extent unequalled perhaps in any other industry. Whilst lacking anything like perfection for this particular field, electricity has gradually attracted greater attention of recent years, and any contribution making the use of this power more effective, is welcome. Mr. Harvey seeks to assist in the matter by his book, containing seven chapters on electricity as applied to mining. Advocates of this form of power are of two types, moderates and extremists; Mr. Harvey is of the former class.

The book is not a treatise for college students, but a handbook for the mining engineer. It assumes a general knowledge of direct and alternating currents such as an intelligent electrician might be expected to possess, and proceeds directly to apply it to specific problems in the art and practice of mining. To those occupying the lower administrative posts it will be most helpful. Excellent diagrams, graphs, and illustrations are to be found in abundance and the work is concise and readable. No specific hypothetical cases are dealt with at length, but data are given and examples worked to enable an intelligent official to solve his own problems.

Chapter I deals with the case for electrification by contrast with other existing methods. It is well to note here, however, that many practical engineers are convinced that a distinct change in the regulations relating to mining is overdue. Probably the matter will finally be settled along lines which permit of a wider field for electric lighting. A good explanatory curve is included in connection with the comparison of the efficiency of electricity with each of the older methods. Chapter II on generating plant deals with the matter from both the commercial and technical standpoints, and the facts relating to gas, oil and steam prime-movers are clearly and accurately given. A really helpful financial graph is given, and, although the matters dealt with are not entered into in great detail, the chapter should prove of considerable value.

Chapters III and IV treat of the power house in some detail. They form an important part of the book. Data are given bearing on the choice of a power unit of correct size, and switchboard lay-out is considered in detail. The advocacy of automatic voltage regulators is useful in view of modern alternator practice. The question of protective switchgear is dealt with instructively, and diagrams of connections of several of the more usual feeder protection systems are given. After indicating the physical meaning of resonance a consideration of lightning arresters is next proceeded with. In connection with alternators, earthing the central point is advocated by Mr. Harvey; while he deals in a clear way with the practice of running in parallel. The descriptive diagrams and numerical examples will be found very helpful. This section concludes with a discussion of the improvement of power factor by means of static condensers, phase advancers, and synchronous motors.

Chapter V deals with the surface installation in general, and is illustrative of good practice. It includes a discussion of the Hunter cascade winding arrangement, and covers data relating to cables, the power required to drive a fan, pole and insulator lay-outs, and conductor calculations. A good example of an overhead transmission line is fully worked out. Chapter VI is concerned with underground distribution. The fixing and lowering of cables is treated and the advantages of double-cable working are not overlooked by the author. Pump and haulage gear formulæ are given, with useful

efficiency curves. The claims of the electrical coal cutter, which in many cases form one of the main arguments in favour of electrification, are not unduly pressed by Mr. Harvey. The treatment of the very important question of lighting is on standard lines, but the suggested use of the thermionic valve, as a means of signalling, requires some consideration in view of the delicacy of the apparatus. In the description of batteries an error occurs in the first chemical equation, one of the few in the book.

The final chapter deals with administration. It will be read with interest, but nowadays organisation details differ so much in different countries or even companies, and are so highly developed, that any treatment within the limits of a chapter can be of but slight help. Suggestions are given on inspection and reports and the testing of the conduction of earth systems, instruments and machines, etc. Plant, log books, and costing records are mentioned, while ideas on drawing up specifications for the usual mine equipment are included. A useful index completes the book, which is on sound lines throughout. The reliable compilation of data will render it of value to those concerned with the practical side of colliery work. Indeed, it is not too much to say that every young colliery engineer ought to study it carefully, for it will afford him information of a type which he would take years to acquire by first-hand knowledge.

Recent Progress in Engineering Production. By C. M. LINLEY. London: Ernest Benn, Limited. [Price 42*s.* net.]

MR. LINLEY'S book is prepared to assist engineers who are concerned with the organisation of machine shops, to enable them to keep abreast of the developments which are proceeding in every kind of appliance that is utilised by the mechanical engineer. While, therefore, the machine shop is the central objective, the author has laid under contribution the work of allied departments and industries which cannot be dissociated from that of the recognised manufacturing machines. In this respect, it appeals to a rather different class of readers than those for whom text books on more limited groups of subjects are written. It contains 41 chapters, 303 illustrations, and 340 pages in a crown quarto volume. The examples selected are those of the more recent machines and processes, the knowledge of which may not have filtered down to the busy man preoccupied with his own limited affairs.

In the opening chapter on "Grinding," only the later machines are illustrated—those for surface grinding, heavy face grinding, the grinding of bores by the use of planetary spindles, the turret universal grinder, disc grinders, combined hole and face, and the centreless grinders. This is a typical example of the method of treatment followed throughout the book.

Among the tasks which are related to those of the machine shop, but which are carried on outside it, are the following: Metal cutting by the machine-controlled oxygen jet, and the cutting of tubes, and round and oval holes in plates; hardening and case hardening, with the selection of suitable steels for different purposes; pyrometry, including the optical, the total radiation systems, and the contact system, including the thermo-couple. The chapter on these gives a very informing account of the various systems in use. Other allied subjects are: Machines for engraving, for baling scrap, sawing and filing, centrifugal casting, babbiting, pattern making, the cleaning of castings, stainless steel, electric furnaces, factory lighting, heating, &c. These selections indicate the wide range of matters with which the machinist is not directly concerned, but with which organisers and managers should possess an intelligent acquaintance. All are illustrated with photographs chiefly of approved appliances.

The work of the machine shop is not treated on the basis of a systematic classification of machine types, but in an eclectic fashion. The duties of different machines and the practice involved are discussed. And here, too, the older standardised methods that are presumably familiar to all who have any interest in the subject, are passed by, in order to leave room for the inclusion of the later machines and their duties—those of the past fifteen years. In gear cutting and gear grinding, for example, Chapter VIII, the use of rotary form cutters is not touched on, but instead, the methods of planing are described, with the involute rack, and the pinion cutter, with their applications in the cutting of spur, spiral, and helical gears. Gear tooth testing, and tooth grinding are included. So, too, the chapter on bevel gear practice does not include the older rotary form cutter system, but only the more recent generation of spiral gears, illustrated by means of the Gleason method, and including the burnishing of teeth and the method of hardening them.

Lathes, milling, drilling and broaching machines each have separate chapters—all being illustrative of recent developments. Designs ante-dating the introduction of high speed steel, are omitted. Instead, continuous tooling, gang milling, heavy duty work, multiple spindles and so on, receive good treatment. Automatic and multiple tool lathes occupy considerable space; thread milling, and hobbing splined shafts are described. Subjects, too, which are included in departments of the shop, and are vitally associated with its practice, are gauges, the cutting off of bars, the balancing of parts, hardness, and impact tests, tests for screw threads, thread gauges, and comparators, belts and pulleys.

This is an encyclopædic work that can be recommended to the men for whom it has been prepared, and to whom it is important though difficult to keep abreast of developments. It is well written, well printed and very fully illustrated with many photographic views and some line drawings.

ELECTRICAL DEVELOPMENTS IN PALESTINE.

By H. HOME, M.Inst.C.E., sometime Assistant Director (Construction), P.W.D., Government of Palestine.

Two years ago considerable interest was taken in England in the award of concessions to Mr. P. Rutenberg, C.E., by the Government of Palestine for hydro-electric development in the Jordan Valley and the distribution and sale of energy for all purposes in Palestine. It is proposed to describe the works which are to be commenced in the present year in instalments of the completed scheme and the subsidiary works which have already been carried out by Mr. Rutenberg.

The most important geographical feature in Palestine is the deep rift of the Jordan Valley—682 ft. below sea level (Lake of Tiberias) to 1,292 ft. below sea level (Dead Sea)—separating Palestine from Trans-Jordania. The rift is continued to the north, Lake Merom being on its axis, and closes opposite the massif of Mount Hermon. The overflow from Lake Merom (Fig. 1) discharges into the Lake of Tiberias and the Lake of Tiberias into the Dead Sea by the River Jordan. About five miles below the southern end of Lake Tiberias the Jordan receives its only large tributary, the River Yarmuk (Fig. 2). The position of Lake Tiberias, forming as it does a large storage reservoir of a surface area of about 170 million sq. metres, is the key to the scheme for hydro-electric power production in Palestine.

The rainfall contours, which are given in Fig. 3, page 36, show the rainfall to be greatest in the mountainous region north of Lake Merom and deficient in the Jordan Valley below the Lake of Tiberias. Centuries of neglect have succeeded in destroying the natural forests, and, with the exception of a few plantations and the stunted remains of the ancient trees, the hills of Palestine are entirely bare; the run-off is therefore very rapid. Insufficient data as yet exists to give a determination of the ratio of run-off to the total rainfall, but the importance of conservation is imperative. Exact quantities of the rainfall in the different districts over an extended period are also wanting, but two facts are of interest. Since the Kitchener survey, 1883–84, the level of the Dead Sea has risen 18 or 20 ft.; this may be evidence that Palestine is subject to periodic changes of moisture and drought. Again, in examining aqueducts of the Herodian period at Jerusalem, Cæsarea, and in the Jordan Valley, it has been noted that the cross sections and gradients were designed for discharges equivalent to that given by the springs to-day in a normal year.

It is, then, probable that the rainfall in Palestine 2,000 years ago was very similar to that of to-day. Still more ancient aqueducts and cisterns carry the record further back with similar conclusions. Having, then, in view the importance of Lake Tiberias as providing storage for the winter rains, the first part of the projected development arranges for the utilisation of the 50 m. fall between the lake and Jisr-el-Majameh, as shown in Fig. 2. It is proposed to divide this fall into two steps, with one power house near Jisr-el-Majameh and the other about 5 km. higher up the Jordan. The first power house being placed below the junction of the Yarmuk and the Jordan, the waters of both rivers will be available for power purposes. A dam on the Jordan will retain the water to a depth of 6 m. and form a reser-

Fig. 1.

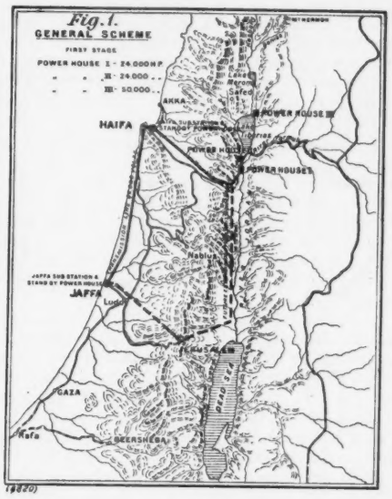
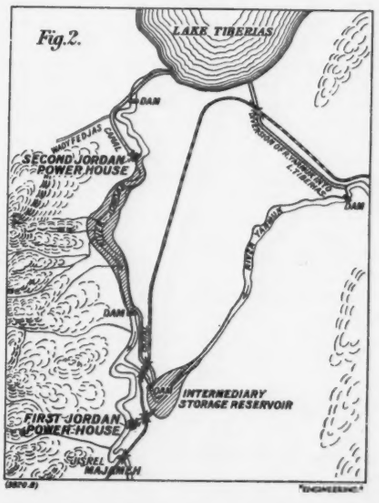


Fig. 2.



voir with a surface area of over 1,000,000 sq. metres. A dam on the Yarmuk, retaining water to a depth of 8 m., will form the intermediate Yarmuk reservoir. This reservoir will store the Yarmuk water during the night. A canal 1·9 km. in length will connect the Jordan reservoir with the Yarmuk reservoir, from which a canal 400 metres in length leads to the Jisr-el-Majameh fore-bay, penstocks, and power house. The normal level in the Yarmuk reservoir will be 224 m. below sea level, the water level of the tail-race canal 249 m. below sea level, giving a useful difference of levels of 25 m. The average yearly discharge of the Jordan and Yarmuk together is calculated at 45 cub. m. per second.

Taking into account the regulating capacity of Lake Tiberias, i.e., that water will be used only when and as necessary, which is of importance because the night load will be considerably less than the day load, the capacity of the power house has been computed for an average output per day. The

horse-power developed at the turbine shafts will be :—

$$\frac{45 \times 25 \times 0{\cdot}80\ \% \times 1{,}000 \times 2}{75} = 24{,}000 \text{ h.p.}$$

The yearly quantity of energy available from the first Jordan power house, allowing 25 per cent. for transmission losses, transformers, &c., will be 60,000,000 kw.-hours. It is proposed to instal at first three turbine sets of 6,000 h.p. each. The canals, dams and ancillary works will be designed for a maximum capacity, and it will be necessary only to add new generating units as the demand increases.

The second power house on the Jordan using about 24 metres fall will be erected only when the limits of the maximum capacity of the first Jordan power house are reached. Mr. Rutenberg proposes then to divert the Yarmuk waters into Lake Tiberias, as indicated in Fig. 2. Both power houses will then take all the waters of the rivers Jordan and Yarmuk, the waters drawn from Lake Tiberias passing through the turbines of both of them.

Transmission of Energy.—Transmission from the power house will be at 66,000 volts to the main transformer stations in Haifa, Jaffa and Jerusalem, as indicated in Fig. 1. The Haifa and Jaffa regional transmission lines are proposed to be for 15,000 volts; the town areas will be fed by underground cables and overhead lines of 6,300 volts, the local low-tension distribution nets having a voltage of 380/220 volts.

The continuity of supply will be secured by stand-by Diesel power houses in Haifa and Jaffa, generating at 6,300 volts. The Jaffa power house is completed and is supplying energy to Tel-Aviv, the new Jewish city built immediately to the north of Jaffa, and to Jaffa. The installation is of two Diesel sets of 500 h.p. each and a third of 250 h.p. Further extension is under consideration. Exterior and interior views of the station are given in Figs. 4 and 5. A transmission line 15 km. in length is now erected from the Jaffa power house, to transmit to Surafend at 15,000 volts, to supply the military camps situated to the south and east of Jaffa, this transmission being a part of the future Jaffa district medium tension network. The Haifa power house is now under construction, the installation comprising four Mirrlees Diesel sets of 300 h.p. each to begin with. A small station is being erected at Tiberias on the western shore of the lake, one Diesel set of 100 h.p. and another of 50 h.p. being installed.

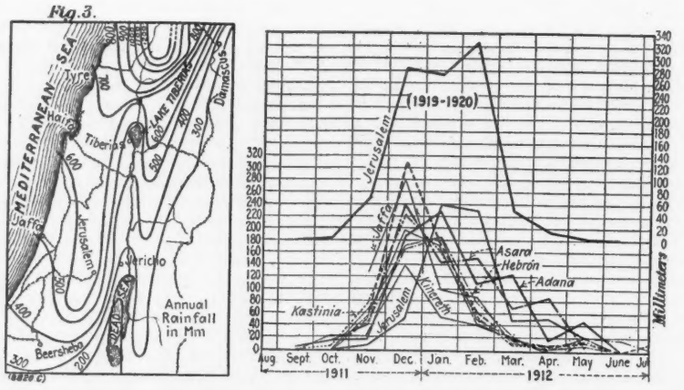
The population of Palestine is about 749,500. Of these about 584,500 are Moslems, 85,500 Christians and 80,000 Jews. The principal towns included in the above scheme have a population as follows :—Jerusalem, 64,000 ; Jaffa, 46,000 ; Haifa, 40,000. It is improbable that Jerusalem will ever become a manufacturing town, its position in the mountains is one factor which alone forbids the development. Jaffa with its neighbour Tel Aviv is increasing in population and already these take the full output of the power house.

The extensive orange groves near Jaffa require irrigation, the water being pumped from wells. At the present time upward of 2,000 kw. are required. No doubt in the future more extensive orchard planting in the coastal region will make further demands for power. The plain of Esdrælon stretching from Haifa 30 miles to the south-east is also suitable for development by low lift pumping.

At Haifa the output of the sub-station is already absorbed. Should Haifa develop as a port for Syria, and the claims of Haifa because of its position as the natural gateway to the great hinterland of the Hauran and the best site on the coast for the construction of a commercial harbour are very strong, the demands for power will be considerable. A large Portland cement works is being erected, and an important mill and oil factory are in operation. The Government railway works are also situated there. It is possible that at least some sections of the railway may be electrified. Tiberias with its wonderful winter climate, its Roman baths and beauty of environment should become a winter resort of first-class importance.

ELECTRICAL DEVELOPMENTS IN PALESTINE.

Fig. 3.



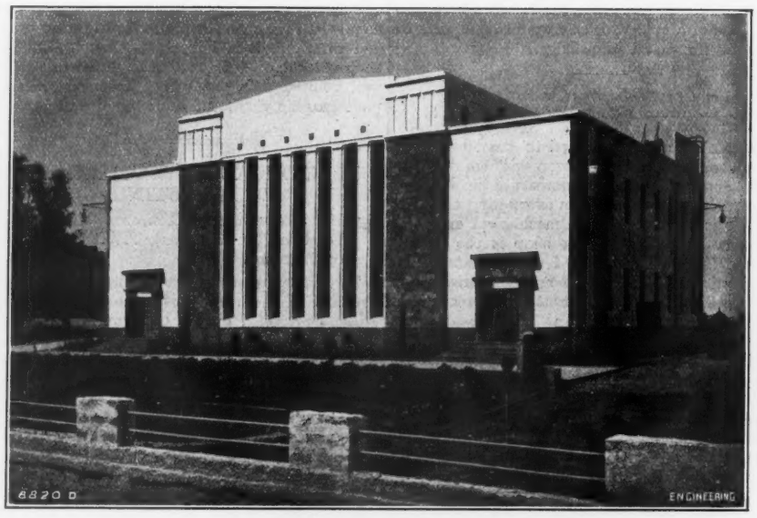


FIG. 4. JAFFA POWER STATION; EXTERIOR VIEW.

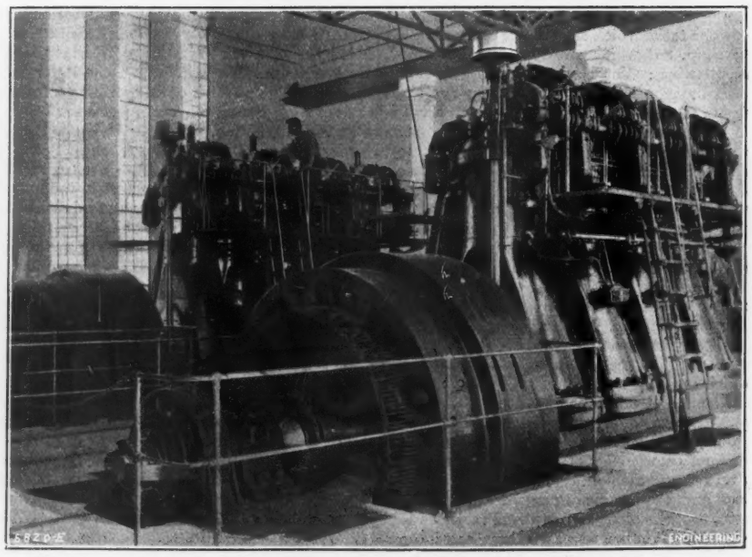


FIG. 5. JAFFA POWER STATION; INTERIOR VIEW.

MECHANICAL GAS PRODUCER.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, LONDON.

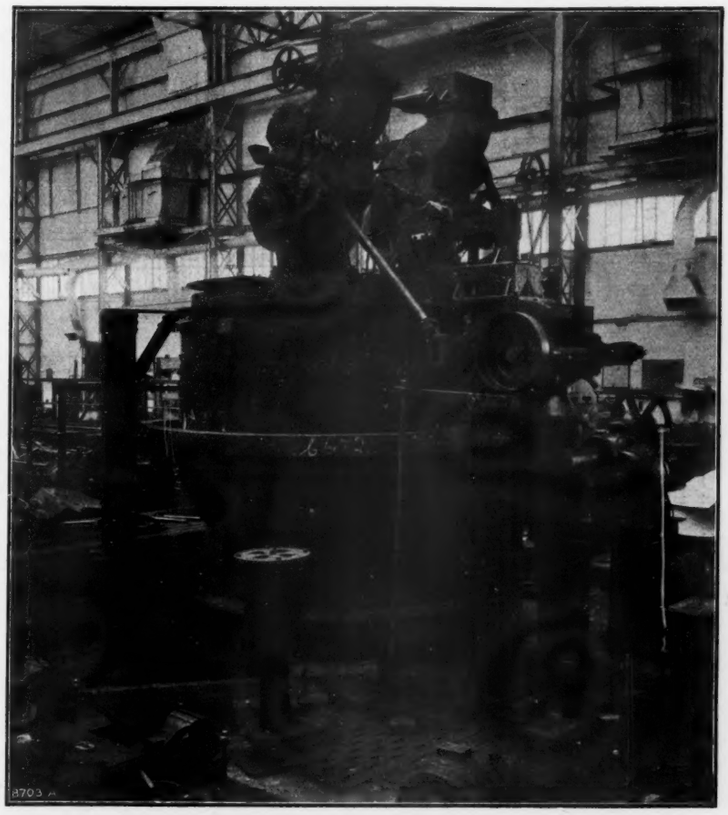


FIG. 1. GENERAL VIEW OF THE 4,000 LB. PRODUCER.

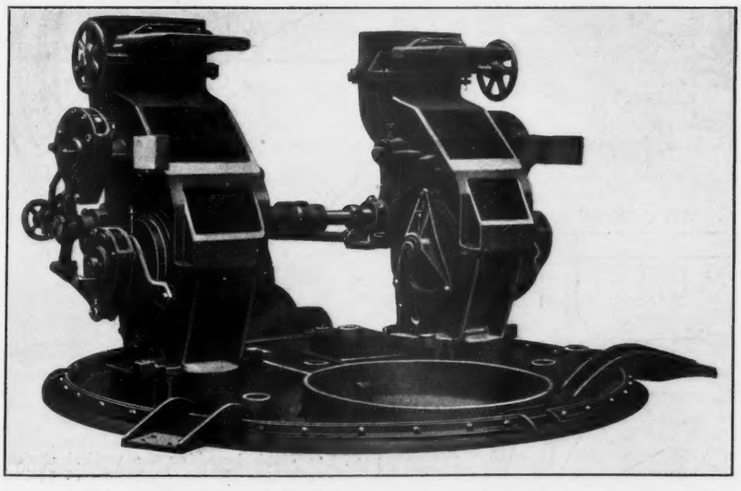


FIG. 2. TOP OF PRODUCER AND MECHANICAL COAL FEED.

THE WELLMAN MECHANICAL GAS PRODUCER.

To say that, broadly speaking, the gas producer remains what it was sixty years ago in the days of Siemens, does not in any way belittle the great strides made in the construction and working of such producers. The improvements of recent years have been in the direction of the further use of mechanical devices. The mechanical producer is not, however, likely to supersede the stationary type. Each class has its advantages. The development of large units naturally favours mechanical operation in the interests of increased efficiency as well as of the welfare of the workers. Mechanical operation is mainly applied to the coal feed, the stirring of the fuel bed and the ash removal, and it generally implies rotation of the whole producer body or of some parts of it. The stirring of the fuel may simply be a levelling or raking, or it may mean a real digging into the fuel to its full depth. The rotating part may be the body, the top, the ash pan, or the grate.

In the Wellman mechanical gas producer of the Wellman Smith Owen Engineering Corporation, Limited, of Willenhall, South Staffordshire, and 36-38, Kingsway, W.C.2, illustrated above and on pp. 38 & 39, mechanical operation is developed to the fullest extent, and the rotating parts are the producer body and the ash pan, while the top supporting the coal feed remains stationary. Mechanical Wellman gas producers have been on the market for eighteen years. This new model, known as the L type, is made in two sizes. The L 10 type, which we illustrate, has a diameter of 10 ft. measured inside the brick lining; the L 8 type has a diameter of 8 ft. The larger type has an efficient gasifying capacity ranging from 2,500 lb. up to 4,000 lb. of bituminous coal per hour; in the smaller type the capacity range is from 1,500 lb. to 2,750 lb. The most desirable fuel would contain from 30 per cent. to 40 per cent. of volatile matter, 50 per cent. to 60 per cent. of fixed carbon, and less than 15 per cent. of ash fusing at 1,200 deg. F. or over. With this fuel the overload capacity of the L 10 producer rises to 4,500 lb., and this capacity can, thanks to the automatic operation, be maintained continuously. Producers of this new type are in use in considerable numbers in the districts of Birmingham, Newcastle and Stoke, and in Scotland; a battery of producers is being erected at Skinningrove, and the machines have also been introduced on the Continent.

Fig. 1, annexed, is a view of an L 10 machine, while Fig. 2 shows the top and the mechanical coal feed. Elevations, a plan and two horizontal cross sections are given in Figs. 3 to 7 on page 38. Of the illustrations on page 39, Fig. 8 shows the poker mechanism and bearing, and Figs. 10 and 11 the construction of the poker. Fig. 9 shows a part of the coal gate. Fig. 12 is a diagram of the arrangement of the Wellman steam injector blower, and Figs. 13 and 14 illustrate the construction of the mechanical feed and the peculiar path which the poker describes in stirring the fuel and ashes. The coal passes from a bin through the mechanical feed into the producer, as shown in Fig. 13. The L 8 type has only one mechanical feed; the L 10 type is provided with two feeding arrangements, the main horizontal feed shafts being connected together as shown in Fig. 2. The top of the producer is built up partly of removable plates, the top plate being developed into a water-cooling pan and being provided with a flange dipping into a water seal of unusual depth. To the shell, which is made of $\frac{3}{8}$-in. plate, is bolted the main driving gear and track ring, which is made of a steel rail running on three rollers supported on the three columns which bear the main load of the producer; the rollers rest on substantial box brackets riveted to each of the three columns (Fig. 1). The plane of the track ring is above the centre of gravity of the producer. The columns further support the electric motor and the gearing which slowly rotates the shell, about seven times per hour, and which operates all the other movements. The top is stationary above these parts; the ash pan takes part in the movement of the shell, but indirectly and intermittently. The ash pan is carried on a ball bearing *m* (Fig. 3), which is supported in a heavy cylindrical casting resting on the foundation; the casting further serves as part of the blast duct. The lower portion of the producer and the ash pan are generally full of ashes; these ashes transmit the torque of the shell to the ash pan, which moves with the shell except when held by stops which engage with an oscillating arm; this arm derives its periodic motion from a cam and lever in the producer drive. The ash plough is vertically adjustable and can be lowered and raised at will.

An electric motor of from 3 h.p. to 5 h.p. drives the various movements through a novel worm and spur reduction drive which is illustrated in the figures. The motor *a* (Figs. 4 and 6) drives through its horizontal shaft and Fabroil pinion a steel spur gear *b*. A worm on the shaft of *b* engages with a horizontal worm wheel in the double reduction gear *c*. This worm gear runs submerged in oil, the gear-case being mounted on the machinery column. The upper end of the vertical shaft projecting from the gear case carries a crank which may be seen in Figs. 4 and 6. The vertical shaft also carries a worm engaging with a wheel, the horizontal shaft of which ends in the bevel pinion *d* gearing with the circular rack running round the track ring of the shell. This provides the necessary rotary motion for the shell. The crank *c* mentioned above operates the other movements through the intermediation of a connecting rod and a rocking lever *e*. From the end of the rocking lever the connecting rod *j* extends obliquely upward to the coal-feed mechanism, which thus receives rocking impulses. From the rocking lever *e* there also extends a curved lever fitted with a pawl which engages with the ratchet wheel *g*. On the horizontal shaft of *g* is fixed a cam disc; the block and lever *h* working in conjunction with this cam are connected by a long vertical rod (Fig. 4) to an oscillating arm which stops the slowly revolving pan when the arm is depressed so that its free end rises and comes into contact with one of the stops on the ash pan. In this way the ash pan movement is controlled and rendered periodic. A shearing pin is inserted in the connecting rod, which

MECHANICAL GAS PRODUCER.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, ENGINEERS, LONDON.

Fig. 3.

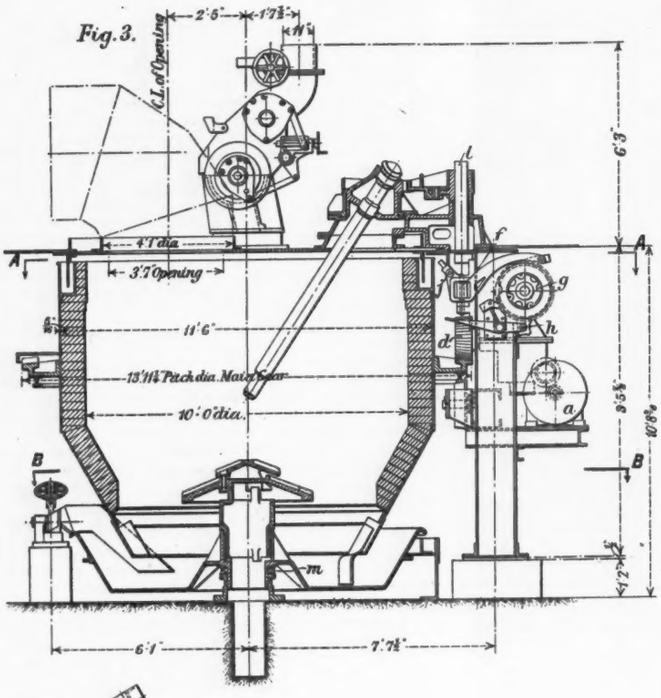


Fig. 4.

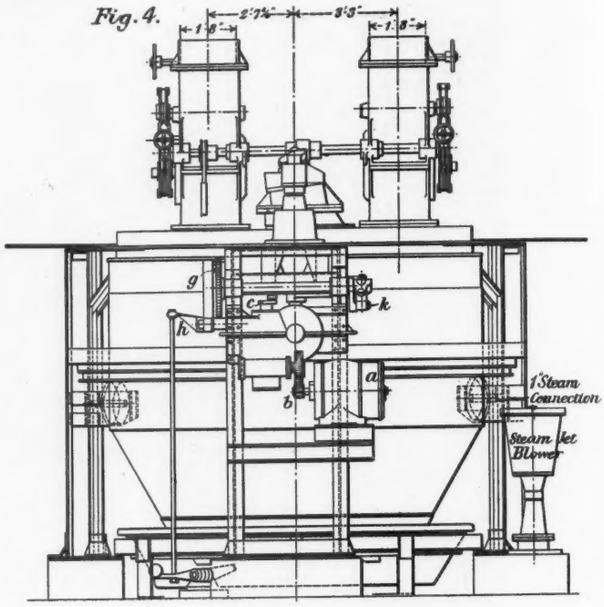


Fig. 5. PLAN OF TOP

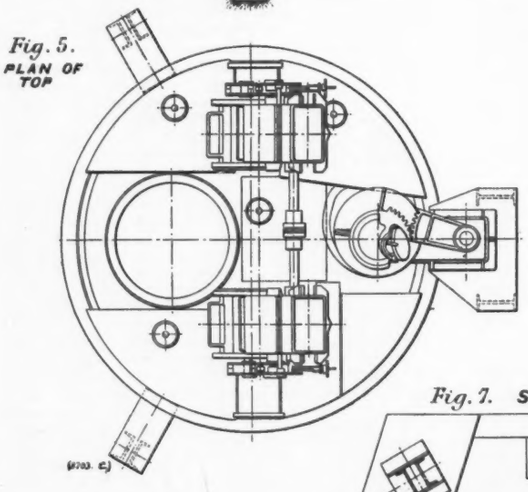


Fig. 6. SECTION A.A

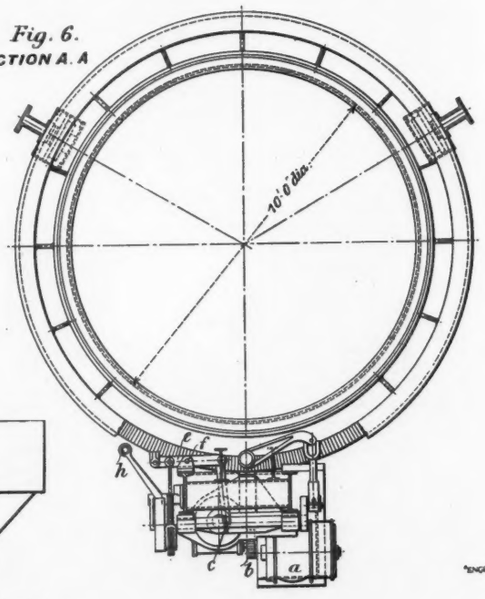
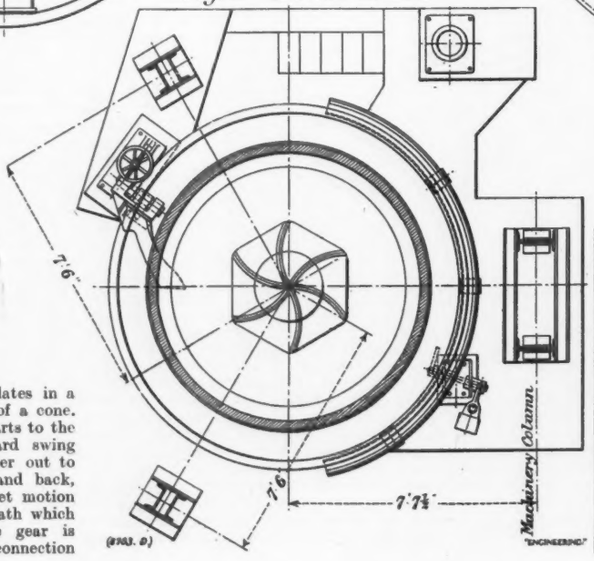


Fig. 7. SECTION ON B.B



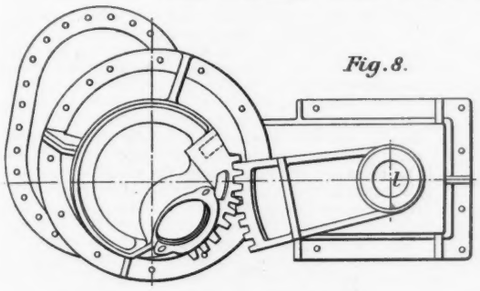
would break if there were any serious resistance to the movement. Such protective devices, preventing damage to the mechanism, are also added to other parts.

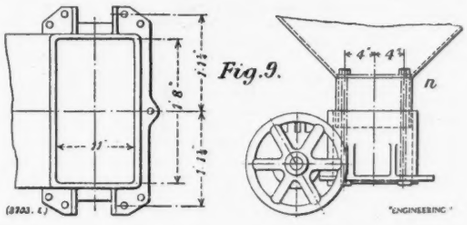
The above mechanism also operates the poker drive. The shaft carrying the ratchet wheel *g* ends in a crank *k*, which is connected to another crank oscillating the vertical shaft *l* on which is the segment of the poker mechanism. The poker is mounted in a circular bearing (Fig. 8) inclined at an angle to the vertical, and oscillates in a path which forms the frustrum of a cone. The oscillating mechanism imparts to the poker an upward and downward swing from the centre of the producer out to the brick lining of the shell and back, and as a result of the ratchet motion the poker traces the stepped path which is shown in Fig. 14. The gear is driven through a shearing-pin connection with a crank keyed on the vertical shaft *l*; the poker shearing pin has a diameter of ¾ in. Fig. 14 shows the starting point of the poker and the position it will occupy half an hour later. Before passing to other details it should be mentioned that the worms of the reduction gearing are made of high carbon steel and the worm wheels of phosphor bronze; the reduction gear shafts run in heavy duty roller and end-thrust bearings. All the other bearings are lubricated by grease under high pressure, with the object of keeping out any grit.

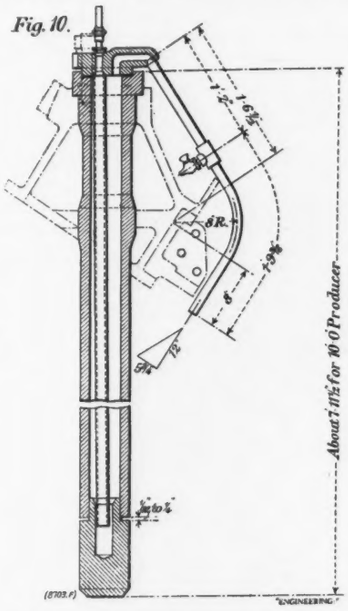
Particulars of the construction of the poker and of its tip are given in Figs. 10 and 11. The tubular poker itself is made of cast iron; it has a length of nearly 8 ft. for a 10 ft. producer, and the tip which is made of 0·6 per cent. carbon steel has a length of 12 in. and a 2 in. hole. Cooling water enters through a hinged pipe and is withdrawn through a stationary central pipe extending nearly to the bottom

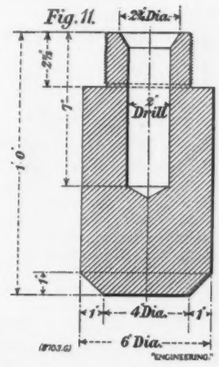
MECHANICAL GAS PRODUCER.

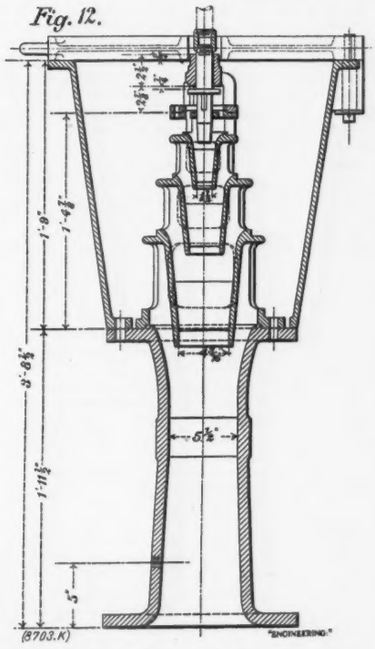
THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, ENGINEERS, LONDON.

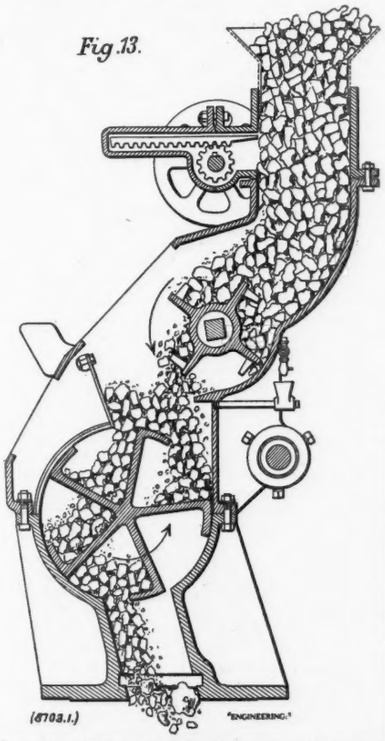


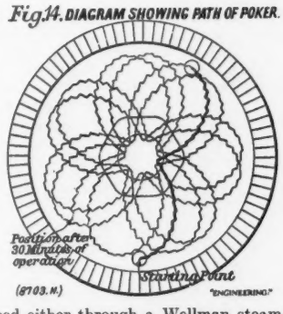












of the poker. From the poker the water is discharged on to the top plate of the producer and by overflow pipes to the top water seal and on to the ash-pan seal. From 5 gallons to 7 gallons of water are required per minute for all cooling purposes. The cooled poker tip which is screwed into the barrel will last about six months. The poker can be removed and a spare one put in place in a quarter of an hour.

The movement of the mechanical poker extends down into the combustion zone; the poker is at work all the time, keeping the fuel free and loose, maintaining a fuel bed of uniform density, preventing the clinkering of the walls and forcing any incipient clinker down into the ash pan. The effect of the poking extends down into the ash pan. The peculiar movement of the poker is one of the distinctive features of the new Wellman producer; in other constructions the poker, a straight bar with inclined end, has been rotated about its own longitudinal axis, or it has been developed into a piston or made to work like a percussion tool.

The blast required for working the producer is introduced either through a Wellman steam injector blower (Fig. 12) or through a steam turbo-blower. The latter is preferred in America, the advantage being that air and steam fuel can be controlled independently. The steam enters the blower, as illustrated in Fig 12, at the top, through a pipe and valve controlled by the man on the producer platform above, and passes into the producer through the cylindrical casting, shown in Fig. 3, impinging upon the blast hood (Fig. 7). This hood is a hexagonal casting, having conical sides from under which the blast streams from the central duct into the ash zone. Ribs on the surface of the hood assist in the down flow of the ashes to the ash pan; the hood and its blast pipe revolve with the ash pan. The scraper, which is fixed, loosens the ash from the sides and bottom; the revolving ash pan carries the ash round, and the face of the plough is so shaped that the ash, coming up against the blade, is lifted up and pushed out of the pan and deposited at some spot on the floor. The position of plough and scraper with respect to the direction of the rotation of the ash-pan is such that the ash is first scraped from the bottom and then lifted by the plough. There are also internal scrapers attached to the blast hood.

The sectional diagram, Fig. 13, will further explain the mechanical coal feed, a view of which is given in the reproduction, Fig. 2. The coal descending from the bin passes first a four-bladed measuring drum rotating in the direction indicated, so that the upward-moving blades tend to lift the coal and prevent choking in the spout from the bin. The coal then enters the coal-feeding drum proper, which is divided into five compartments in order to obtain a frequent feed in small quantities at a time; the feed is operated by the intermittent mechanism as above described. The lower drum is kept lubricated by a drip feed of water. A hand wheel attachment permits alteration of the length of the driving lever. A shearing pin safety device is also incorporated in this gear. By means of a coal gate shown in the left-hand upper portion of Fig. 13, the feed can be shut off. Fig. 9 illustrates the bottom of the coal bin and shows the sleeve connection which is introduced to prevent the weight of the bin being transferred to the top of the producer. The coal should all pass through a 4-in. ring; the fines may run up to 40 per cent.; when the fines are to be removed the coal should be sized to pass through a 3-in. ring and over a ½-in. screen. The coal is delivered in a thin layer over the entire surface of the fuel bed in a practically continuous flow.

The gas produced is taken from the producer through a lined mild-steel duct, let into the steel top plate; the exit hole can be seen both in Figs. 3 and 5. The free end of this flue is usually connected to a gas valve so that any one of a battery of producers can be isolated. Beyond the valve is a dust catcher. Near to the gas exit three holes will be seen in Fig. 5. These holes serve for the insertion into the producer of the observation rods by the aid of which the man in charge watches the process of combustion. The rod is of sufficient length to penetrate right through the fire into the level of the blast hood, which will be in the ash zone. The rod is provided with a stop pin to rest on the rim of the observation hole and is left in position for several minutes. When withdrawn the lower end of the rod will be dark, though hot; above that will be a reddish length of about 12 in. marking the combustion zone; the upper portion having been exposed to the vapours will be blackish with tar deposits, and higher up still there will be a sooty portion, indicating contact of the rod with the green coal.

When the producer is intended mainly to yield a gas for heating metallurgical furnaces, the gas should leave the producer at a temperature of about 1,200 deg. F. In that case the thickness of the green coal zone should not exceed 8 in. This gas will look

brownish black in the observation hole. When a "cold gas" is wanted, of 180 B.Th.U. (against 150 B.Th.U. per cubic foot in the former case), the thickness of the zone of green coal should be larger, about 12in., and the gas should leave the machine at about 700 deg. F. Such gas will appear bluish white. Only two men are required in attendance, one on the top platform and one below; they can look after the four producers of a battery.

COAL CONVEYING PLANT ON THE RIVER TEES AT PORT CLARENCE.

By GEORGE FREDERICK ZIMMER, A.M.Inst.C.E.

OWING to the variation in the topographical conditions of our ports, mechanical loading plant for the shipment of cargo and bunker coal may be classed, generally, under three groups. The land surrounding the ports is, in the majority of cases, low-lying, necessitating the raising of the coal very considerably in order to dump it, by gravity, into the large vessels of to-day. This process of elevating the coal is accomplished either by hydraulically or electrically operated coal hoists, in which the full coal trucks are raised bodily to the required level and there emptied by tipping into the vessel by shoots, which are as a rule of such construction as to prevent damage to the coal by minimising the drop. By the second method, the coal trucks are dumped at rail level, by way of an underground hopper, on a continuous running conveyor, generally of the band type, which transfers the coal along a gently inclined path to the required level and thence by similar shoots into the vessels. A third type of plant is adopted at ports which are so fortunately situated topographically, that the surrounding ground is at a sufficient altitude for the rail level on which the coal trucks arrive to be well above the vessels at the wharf, so that it is not necessary to expend power for the purpose of elevating the coal, which can be lowered by gravity down suitable shoots into the vessel. The installation described below, and which we illustrate on Plate IV and on page 44, comes under this third category.

Notwithstanding the favourable conditions existing at Port Clarence, on the River Tees, the facilities for mechanical loading at this important port have hitherto left much to be desired. Messrs. Dorman, Long and Co., Ltd., have accordingly sought for some method of loading coal mechanically which would eliminate some of the drawbacks in existing installations. One main end has been to secure such absolute flexibility that a vessel could be loaded in all its hatches, with a cargo of 6,000 to 7,000 tons of coal, by shifting the loading shoot from hatch to hatch instead of altering the moorings of the vessel.

The plant was required to fulfil the following conditions:—Cargo and bunker coal of all sizes to be transferred at the rate of 500 to 600 tons per hour from the railway siding for a distance of 700 ft., to the wharf front, where the loading facilities command a quay frontage of 300 ft. The working crew was to consist solely of the locomotive crew, one hopper man and one operator. It was decided, accordingly, to effect the work by three band conveyors, respectively 317 ft., 171 ft., and 52 ft. in length, and all 4 ft. wide. To ensure a minimum breakage of coal, vertical drop at all points of transfer was to be either completely avoided or reduced to a minimum.

The final designs were got out by Messrs. Head, Wrightson and Co., Limited, Thornaby-on-Tees, working in collaboration with the engineers of the Dorman group of companies.

As is perhaps best seen in Fig. 1, Plate IV, the plant consists of three main portions, viz., the stationary feeding gantry, shown on the left; the swivelling gantry, and the jib lattice boom, with its loading shoot. This will be seen on the extreme right of these figures. The maximum travel of the coal on the three band conveyors provided in these structures, is about 540 ft.

The stationary feeding gantry is a substantial steel structure about 342 ft. long, 30 ft. wide, and 48 ft. high. Its general construction is very well shown in Fig. 8, page 44, and details of part of it to an enlarged scale are reproduced in Fig. 3, Plate IV. The upper part of the gantry is provided with two standard rail tracks for the hopper wagons which bring the coal. On the inland side of the gantry is siding accommodation for wagons holding 15,000 tons of coal. The trucks are shunted on to this gantry in trains of eight wagons and the coal is dropped by gravity through their bottom doors into eight steel bunkers with a capacity of 50 tons each, making 400 tons in all. Beneath these bunkers the first of the three band conveyors (to be described later) is located. This can be fed from any or all of the eight bunkers, through outlets with adjustable gates and suitable feeding-on shoots.

The two main longitudinal girders of the gantry are pitched 23 ft. from centre to centre, and these are supported by nine trestles (of which only five are included in Figs. 1 and 2), varying in length with the slope of the ground. The spacing of the trestles is 46 ft., except in the case of the second and third, between which the distance is 20 ft.

The two main members of the supporting trestles are splayed; and the first four are self-contained and cross-braced, the remainder being composed of a pair of stanchions consisting of a vertical and a splayed member. These double supports are sufficiently far apart transversely for the housing of the band conveyor on a lower deck. Within the bays of the last four trestles the eight steel plate bunkers are suspended from the two longitudinal main girders, and since these bays are 46 ft. long, the bunkers, two to each bay, are about 23 ft. long each, and also 23 ft. wide. The bunker sides make an angle of 45 deg. with the horizontal. It will be seen from Fig. 3 that the bottom-door coal wagons are of the same length from buffer to buffer as the bunkers viz.: 23 ft., so that if a train of eight wagons is correctly spotted on the gantry there will be a wagon over each bunker. The construction of the last five trestles, corresponding to the eight bunkers, provides a clear space of about 10 ft. for the housing of the first band conveyor. The deck of this is about 35 ft. 10 in. above ground level. The length of this first conveyor is 316 ft. 9 in. and since only the first 192 ft. are located under the upper deck of the gantry an additional braced steel structure had to be provided for the support of the remainder of the conveyor. Since this subsidiary extension has only to support the conveyor and its load, a relatively light truss construction suffices. This is, however, carried, in addition to an intermediate trestle, by a substantial tower at its waterside end (see Fig. 4) which also serves to support the inshore end of the swivelling and traversing gantry of the second conveyor, and will be described in conjunction therewith.

As already stated, the minimum length of the first band conveyor is 316 ft. 9 in. long from centre to centre, while its width is 4 ft. As the band stretches in course of time, it may ultimately become a few feet longer. It is of compound cotton-rubber construction, consisting of six uniform plies of cotton duck having a solid rubber face on the carrying side and edges $\frac{3}{16}$-in. thick, and backed with rubber $\frac{1}{16}$-in. thick on the pulley side. The cotton duck used weighs 32 ozs. per yard of 42 in. width, and has a breaking strain of 350 lb. per inch of width. The substantial nature of this conveyor band may be realised from the fact that it weighs over 5 tons.

The troughing idlers are provided with ball bearings and arranged for forced grease lubrication, they are pitched 4 ft. from centre to centre, while the return idlers are pitched 8 ft. apart. The driving terminal is located at the delivery end, *i.e.*, at the waterside end of the conveyor. The driving drum of 4 ft. diameter is rotated by a double helical machine-cut spur gear reduction and countershaft driven by a Renold silent chain, from a 40-h.p. motor, situated in a small motor-house superimposed upon the trestle which supports both the stationary and the swivelling gantry. A screw take-up is provided at the inland terminal which is also fitted with a 4-ft. drum. Two snubbing idlers 3 ft. in diameter are provided at both terminals, for the purpose of leading the conveyor band from the 4-ft. terminal drums to the level of the return run. The coal is delivered into a hood-like receptacle which develops into a shoot feeding on to the second band conveyor.

With the apparatus thus far described the coal is carried to a point within 117 ft. from the quayside. Here it is delivered on to a second band conveyor of similar width and make to that already described, and driven also from its delivery end. This conveying belt is 171 ft. long, and is supported on a gantry which can be swivelled about the "swivel trestle" shown in Fig. 1, Plate IV. In addition to swivelling about this point, this gantry can also be traversed in the direction of its length, so that its outer end can be accurately adjusted to the ship's hatchways, whatever the angle of swivel may be. The second band conveyor within this gantry has a length of 171 ft. between centres of the end drums, and a width of 4 ft. Its other features, including the main drum, are identical with the one already described; its driving terminal is also at the delivery end, as stated. This gantry, which is 12 ft. high and 11 ft. wide, is 160 ft. long from the inshore end to the centre of its turntable at the wharf end, beyond which it terminates in a driver's cabin, from which the operator has an uninterrupted view of the proceedings.

As is shown on the general plan, Fig. 1, the water front is on an inland curve, or has an inland concavity, a circumstance which renders the somewhat complicated coaling proposition still more complex. The path described by the delivery end of the installation must obviously follow the water line. The distance, therefore, from the feeding point, which is central with the "swivel trestle" at the junction of the stationary and swivelling gantries, to the quay, varies considerably over the 115 ft., in either direction, from the centre line, over which the delivery end of the radial gantry can be swivelled. As already indicated the variations are compensated for by providing a radial traverse to the gantry, in addition to its swivelling motion.

This second gantry, it will be seen, is constructed as a single intersection trussed girder, but it is of heavier build than that provided for the extension of the first gantry. Its total length is about 185 ft. Its outer end rests on a turntable which, in its turn, is carried by a bogie running on rails, to which further reference will be made later on. The water end of this swivelling gantry terminates in a large built-up crane post or column (see Fig. 6) which carries the shoot by which the coal is delivered on shipboard.

The centre of this post is 25 ft. distant from the centre of the bogie turntable. It is constructed of steel plates and angles, and is strongly braced. Its lower end is about 35 ft. above quay level, whilst the uppermost part is about 46 ft. above quay level. Here the control cabin is mounted. This rotates with the "crane post" and shoot. The hollow "crane post" is supported on two conical rollers on each side, which run on a circular cast-steel roller path, permanently attached to the swivelling gantry structure. As additional support for steadying the post in its rotation, and to take slewing stresses, cast-steel guide rollers are also provided which run on horizontal roller paths near the top and the base.

The bogie, which supports the wharf end of the radial gantry by a turntable, travels on four rails (see Fig. 5, Plate IV). These are grouped in two pairs at 3 ft. gauge, and are 20 ft. apart from centre to centre of the two tracks. The wheel base of this bogie is 35 ft. It rests on eight track wheels arranged in four pairs. Fitted to it is an electrically operated winding drum, round which a wire rope passes, both ends of which are permanently anchored to the ground at the two extreme ends of the "swivelling" travel, so that the delivery end of the gantry can be spotted at any part of its reach on the wharf by winding the rope in one or the other direction.

At the junction of the first and second gantries stands the trestle tower already alluded to, it provides support to the forward end of the first and the rear end of the second gantry bridge. This trestle is of the portal type, and at its lower portion it has a table-like superstructure on four uprights, strongly braced (Fig. 4). The upper surface of this table is 14 ft. 8 in. above ground level. On it is a circular rail track, 11 ft. in diameter, on which a turntable revolves. The second, or swivelling gantry, rests on this turntable in such a way that it can be traversed radially along a roller path towards the land side for a maximum distance of 42 ft. 6 in. and a minimum of about 10 ft. 4 in. Straddling this turntable are a pair of lattice braced supporting trestles which are bridged over at their upper end where they support the first gantry, with its housing for the motor. The space between these uprights is sufficiently wide to allow the swivelling gantry to swing freely between its extreme positions (see Fig. 8, page 44).

The jib lattice boom which supports the last of the series of three conveyors, is about 55 ft. long and is attached at its rear end by means of a long hinge pin to the lower end of the hollow "crane post." The jib can be slewed round through 45 deg. on each side of the centre line. This is accomplished by a cast steel spur rim bolted to the conical roller path already mentioned. In gear with this spur wheel is a cast steel pinion, operated by an independent slewing motor of 15 h.p., through worm and spur reduction gearing. A slipping clutch is incorporated in the design of the slewing mechanism for the purpose of preventing damage to the gear in the event of the jib boom accidentally fouling any part of the vessel during the adjustment of the jib for coaling.

For derricking the outer end of the loading jib, a cast-iron rope drum is provided in the attendant's cabin and is operated by an electric motor of 25 h.p., through suitable spur and worm gearing. The jib is shown in its lowest position in Fig. 6, while the extreme upper working position and the housed position of the boom when out of use are shown in dotted lines. From the plan, Fig. 1, the reach to right and left of the jib boom may be seen.

The third of the three band conveyors is mounted on this steel boom. As already stated this conveyor is similar to the other two in width and general details. Its minimum length is 52 ft. from centre to centre of the terminal drums. Owing, however, to the restricted space available at the delivery end, the drive of this conveyor is at the feeding end, which is contrary to the arrangement adopted for the other two conveyors

and to the usual practice. None the less, no difficulty has been experienced with conveyors so driven where the other and more natural method by which the loaded belt is pulled, is not applicable. The drive is provided through single reduction double helical spur gear from a 24 h.p. motor, which is located just beneath the driving drum. The tension gear, which is at the jib end, is screw-operated and the sliding blocks which carry the drum shaft support also, at the same time, the delivery shoot for the coal, so that whatever slight adjustment may be necessary in use, when keeping the belt taut, the deflector, yet to be described, will move with the delivery terminal of the band conveyor.

It will be seen from Fig. 6 that the No. 2 band conveyor delivers into a hood which is contracted into a shoot delivering on to the feeding-on hopper of the third band conveyor. Since the relative positions of the delivery point of the second and the receiving point of the third conveyor may range over anything within an angle of 90 deg., the hood is attached to and rotates with the pillar. With this provision the jib, with its conveyor, can be raised, lowered, or slewed in either direction without independent setting of the shoot, or stopping the flow of coal for the purpose of setting the shoot to suit the different positions of the jib conveyor.

A hinged deflector—not shown on the drawings—with suitable extensions, is provided at the delivery end of the jib conveyor and has proved of great assistance in trimming coal and negotiating awkwardly-placed hatches. This deflector, which is rectangular in form, is constructed of steel plates suitably stiffened, the upper end forming a cowl or hood over the delivery end of the conveyor. Two rope drums of large diameter are fitted, one at each side, to the upper end of the deflector. To these are attached the steel wire ropes for adjusting it to any required angle, the adjustment being carried out from the deck of the ship receiving the coal by means of a hand chain operating suitable gearing mounted on the upper booms of the jib conveyor. A double-acting screw-type, friction brake, is provided on the first motion shaft, which automatically holds the deflector in any required position, without resort to additional locking mechanism, thereby allowing of quick and easy variation of the angle as occasion demands, without interrupting the flow of the coal.

The electrical equipment is designed for a 220-volt direct-current circuit. The motors for driving the conveyor belts are shunt wound, those for the fixed conveyors under the bunkers and the swivelling conveyor, being of the protected type with ring-lubricated bearings; while that for the jib conveyor is of the totally enclosed type, fitted with roller bearings. All three motors were required to show a temperature rise not exceeding 40 deg. C., after a full load run of six hours. The three motors for the traversing, slewing and derricking sections are all of the protected, series-wound type, and will run one hour under full load, with a temperature rise of under 40 deg. C.

Automatic solenoid brakes are fitted to all six motors, those on the belt drive as a safeguard against accidental flooding of the belts in the event of a shut-down, due to failure of the current or for any other cause.

For controlling the belt motors three ironclad control pillars are provided, each pillar consisting of a face-plate type starter, fitted with renewable contacts and provided with auxiliary carbon contacts on each step and a no-voltage release. One shunt field regulator of the circular sliding type giving a speed variation of half and full speed, is provided, the regulator being interlocked with the starter by means of an electro-mechanical interlock which automatically short-circuits the field regulator and resistance whenever the motor circuit is open, so that the motor cannot be started with a weakened field. Each control pillar is fitted with a D.P. circuit breaker, consisting of two single-pole magnetically-operated contactors to open the motor circuit on both poles. The circuit-breaker interlocks with the starter, so that it cannot close unless the starting resistance is in circuit. Powerful magnetic blow-outs are fitted on each pole. All circuit-breaking, whether resulting from an overload, or from any other cause, is performed by this circuit-breaker. An overload release is also fitted, and this carries the main current of the motor and is adjustable for a large variation of load. The release operates by actually breaking the coil circuit of the circuit-breaker, thus making it impossible for this to remain closed. Each of the three control pillars is fitted with contacts, so that the jib conveyor belt, the swivelling conveyor belt and the fixed conveyor belt, are started in the sequence named, and stop in the reverse sequence, so that it is impossible for the main belt to deliver coal to the swivelling conveyor and the jib conveyor until both the latter are running at the required speed.

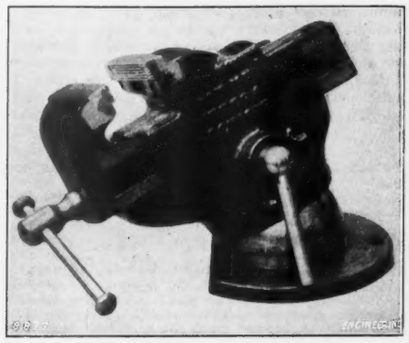
For the traversing, derricking and slewing motors, three reversing drum-type controllers are provided.

Limit switches are provided on the derricking, slewing and traversing motions to prevent over travel in both directions, and are of the self-replacement type.

An emergency switch is provided to trip the crane protective panel and all three belt motor control panels simultaneously, if required.

THE MOULD SWIVEL VICE.

THE advantage of being able to turn many jobs into various positions for filing and fitting will be readily recognised in connection with a large range of small work, which often entails resetting if operations are to be performed in the ordinary straight-jaw bench vice. Annexed we illustrate a handy vice designed to avoid a large part of this resetting. This has been recently brought out by Messrs. William Asquith (1920), Limited, of Halifax. The work is gripped by jaws, pressure being applied by the screw clamping handle. The whole head, with the work, can then be set at any angle or the vice rotated on its base, and when suitably placed the head can be clamped by half a turn of the side handle. We need hardly enlarge upon the convenience



of such an appliance, either from the point of view of ease of working or from that of the advantage of reducing the risk of damage to small articles by less frequent reclamping. With the ordinary bench vice it is often impossible to perform some operations without resetting if the fitter is to work in a comfortable attitude. While, naturally, no claim is advanced that the Mould vice avoids all resetting, it will be obvious that with this fixture the ease of working is greatly increased. The vice has a width of jaw of 3⅞ in. and admits work having a depth of 1½ in. and length of 3 in. Its weight is 18 lb.

The Mould vice is likely to prove particularly useful in the tool room and in connection with die-making, and in many other circumstances. It can be used effectively as a milling and grinding-machine fixture, and this of itself is good proof of its substantial character and of the rigidity of the support which it affords. A plunger is fitted on the left side to lock vice in an upright position.

TENDERS.—It is announced that tenders are being called for at Bucharest in connection with the supply of weighing machines for the Roumanian State Railways. Tenders will be received up to 11 a.m. on January 30. United Kingdom firms in a position to supply British materials are informed that local representation is essential. Further particulars regarding this call for tenders may be had on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W.1, quoting reference A.X. 1593. Tenders are also invited for fire-extinguishing pumps by the same administration, particulars of which may also be obtained from the Department of Overseas Trade, by quoting reference A.X. 1592. These should be submitted before 11 a.m. on January 26.—The Egyptian Ministry of the Interior are requesting tenders, at Cairo, until February 15, for the supply and erection of pumping plant. Fuller information on the matter may be had on application to the Department of Overseas Trade. Reference A.X. 1591 should be quoted.—The Victorian Government Railways Commissioners are inviting tenders for the supply and delivery of one oscillating tool grinding machine, one four-spindle vertical drilling machine, and one single head automatic pipe screwing machine, the latter with a "Landis" type diehead. Sealed quotations, accompanied by a preliminary deposit of ½ per cent. of the amount involved in each tender, will be received at Melbourne, Australia, up to 11 a.m., on February 18, 1925. Further information may be had on application to the Department of Overseas Trade, quoting references A.X 1598, 1599 and 1600 respectively.—The Municipal Council of Johannesburg is calling for tenders, to be presented by February 11, for the supply of one petrol-driven lorry and one trailer. Further particulars regarding this matter may also be had on application to the Department of Overseas Trade, quoting reference number A.X. 1610.

THE INVESTIGATION OF THE SURGE-TANK PROBLEM BY MODEL EXPERIMENTS.*

By Professor A. H. GIBSON, D.Sc., M.Inst.C.E.

WHEN the supply pipe to a hydraulic pipe-line is long and the head is not too great, it becomes advisable and often necessary to use a surge-tank in order to prevent excessive surges of pressure when the turbine gates are closed, and to give an adequate supply during the period of acceleration in the pipe-line following an increase in load.

The problem of determining the rise and fall of level in such a surge-tank, and the period of oscillation of the water column, is not readily susceptible to mathematical treatment. In fact, except in the simplest case—that of a complete sudden shut-down in which, in addition, the presumption is made that the frictional resistance in the pipe-line is proportional either to v or to v^2—the equations of motion are not capable of a direct solution.

In the case of a simple layout a solution may be obtained by a process of arithmetical integration dealing with the cycle in a series of short stages, during each of which the acceleration may be assumed to be uniform. This may be done either for a sudden or a gradual motion of the gates, and for a complete or a partial shut-down or opening-up. The process is, however, tedious, and in a complicated layout and where, for example, more than one surge-tank is used, the method is all but impracticable. The problem would appear to be well adapted for examination by the use of a suitable small-scale model.

The use of such models for investigating somewhat similar complicated hydrodynamical phenomena—such as occur, for instance, in tidal estuaries—was first suggested by Professor Osborne Reynolds, and is now well established. In the present paper the conditions necessary in order that the behaviour of such a model should give a true representation of that of its large-scale prototype are discussed, and a description is given of an experimental plant erected in the hydraulic laboratories of the Manchester University for the purpose of investigating such problems.

A large number of tests have been made on this plant, which has been adjusted so as to represent a wide range of possible full-size installations. In each case the behaviour of the latter installation has been examined by the process of arithmetical integration, and the results of the model tests and of those obtained in this manner are compared in a number of typical cases.

As indicated by these examples, the results of the tests, when interpreted according to the laws of dynamical similarity, are in every case in close agreement with the results as calculated for the corresponding large pipe-line and surge-tank. Any dimensional effect is so small that the error involved in determinations of the height of the maximum or minimum surge following a sudden closure or opening of the outlet-valve does not exceed 1 or 2 per cent., while the calculated and observed periods of oscillation of the surges are also in very close agreement.

The experiments indicate that the results of tests on such a model may be used with confidence to predict the behaviour of the surge-column in any projected installation, however large, or of however complicated a nature.

THE FLOW OF WATER IN PIPES AND CHANNELS.*

By FRANK HEYWOOD, M.Sc.

THE experimental demonstration that the principle of dynamic similarity could be applied with success to the problem of fluid friction provided a new basis on which to build up expressions for the frictional loss in pipes and channels; and this paper is an account of an attempt to co-ordinate much of the available data relating to the flow of water in conduits with the entirely satisfactory results of tests on small-scale experimental pipe-lines.

The author is indebted to Professor A. H. Gibson, M.Inst.C.E., who pointed out that further investigation of this subject was desirable, and at whose suggestion numerous experimental results were collected from various sources and analysed from the new standpoint. Over one thousand experiments were examined in this way, together with the results of tests by the author on two galvanised pipes.

From the theory of dimensions it may be shown that

$$\frac{R}{\rho V^2} = \phi\left(\frac{\nu}{V d}\right) \quad . \quad . \quad . \quad . \quad (1)$$

both sides being independent of dimensions, where R

* Abstracts of papers to be read before the Institution of Civil Engineers on Tuesday, January 13, 1925.

denotes the resistance per unit area of wetted surface, V the velocity in a pipe of diameter d, ρ the density of the fluid, and ν the kinematic viscosity of the fluid. It is to be observed that $R/\rho V^2 = id/4V^2 = 1/C^2$, where i is the loss of head per unit length of pipe, and C is the constant in Chezy's formula $V = C\sqrt{mi}$.

The problem resolves itself into a determination of the function ϕ, which has been done experimentally in a number of cases. Experiments carried out by Dr. T. E. Stanton, M.Inst.C.E., and the late Mr. J. R. Pannell on smooth brass pipes over a very extended range of velocities showed the function to be of the form

$$\frac{R}{\rho V^2} = A\left(\frac{\nu}{Vd}\right)^n + B \quad . \quad . \quad (2)$$

where A, B, and n are constants for pipes of the same relative roughness, *i.e.*, actual roughness of surface divided by the diameter. It remained to be shown that the form of the function was the same for pipes of varying roughness; for the pipes used in Dr. Stanton's experiments, although of small diameter, gave higher values of C than is usual in practice.

Experiments by Messrs. A. V. Saph and E. H. Schoder on galvanised pipes of small diameter, by Dr. C. H. Lander, Assoc.M.Inst.C.E., on steel pipes, and by the author on two galvanised pipes, 2 in. and 4 in. in diameter, show that the form of the function is the same in all cases.

It will be seen that the quantity B, in equation (2), representing, as it does, the limiting value of $f/2g$ in the well-known formula $h = fV^2/2gm$, as the velocity increases without limit, provides a convenient measure of the relative roughness of various surfaces, for pipes of the same relative roughness have the same value of B.

It was necessary to find the relation between $R/\rho V^2$ and ν/Vd or ν/Vm for other than the specific values of B obtained from the experiments just referred to, and this was done by interpolation. In this way, the variation of $R/\rho V^2$ with ν/Vm was represented for surfaces having limiting values of Chezy's C between 80 and 220; and a diagram showing the variation is given in the paper. It therefore becomes possible, given the diameter and surface characteristic of a pipe and the velocity of flow, to determine the appropriate value of C with greater confidence than an application of most of the formulas in general use would justify; and an example is given in support of this statement. In order to render the $(R/\rho V^2) : (\nu/Vm)$ curves of practical utility, it remained to find a relation between the quantity B and the diameter or hydraulic mean depth. The latter quantity has been used for comparing pipes with channels, but doubt is expressed as to the possibility of a strict comparison between channels of very different shape.

A consistent set of results has been obtained by various experimenters on cast-iron pipes, and the relation between B and the hydraulic mean depth, m, for these pipes has been taken as a standard in obtaining similar relations for the other surfaces examined, *i.e.*, concrete pipes and channels, wood-stave pipes and wood troughs, brick conduits, and earth channels. The principle of similarity gives further aid in indicating that if two pipes of different materials D and D′ ft. in diameter are found to give certain equal values of B, and, therefore, are similar, pipes of these materials mD and mD′ ft. in diameter will also give certain other equal values of B. The abscissæ of the B : m curve for asphalted cast-iron pipes have, therefore, been increased or diminished in certain ratios so as to pass through observations on the other types of surface examined. This appears to be a new method of determining the variation of the friction coefficients with the hydraulic mean depth, all previous investigators having treated each class of surface independently.

Two notable exceptions, riveted steel pipes and rough channels in earth, or rivers, cannot be satisfactorily treated by this method, for certain reasons outlined in the paper, and different laws are found to apply in these cases.

TUNNEL UNDER THE VISTULA.—A railway tunnel is being driven under the bed of the River Vistula, which flows between Warsaw and its suburb, Praga, lying on the right or eastern side of the river. The tunnel starts from the old so-called "Vienna" Station in Warsaw, and runs under the Aliza, or Boulevard, Jerozolinska, which traverses the side of the city, and leads to the Poniatowski Bridge. The railway tunnel will have its outlet in or near the centre of Praga, at the old station from which travellers to St. Petersburg used to start before the war. At present the trains from Praga to Warsaw, crossing the Vistula by the old Kierbedzia Bridge, travel round three sides of a square before reaching the Vienna Station. The main object of the tunnel is to allow of through trains running straight from the centre of Warsaw to Moscow and Leningrad, &c. The construction, which has been proceeding for three years, has now reached to the foot of the Poniatowski Bridge, and the most difficult part of the task is now being faced.

FOOD PRESERVATION.

THE Annual Report for 1923 of the Food Investigation Board [H.M. Stationery Office, Kingsway, W.C.], which has just been published, records a large amount of biological, chemical and other observations made in the search for the explanation of the natural processes that affect preservation of various foods, but little in the way of final results. It is obvious that in investigations on subjects such as the growth and development of plants, in which some of the most fundamental experiments can only be made at intervals of a year instead of a few hours or days, progress must often be slow, and it is fortunate that they should receive attention from bodies such as the Food Investigation Board, who are not frightened of the large scale and protracted duration of the necessary inquiries. Practically all the large subjects that affect refrigerating engineers are under further investigation, and there is reason to hope that definite contributions to scientific knowledge of the deterioration of food and the art of preserving it may result in the near future. Meanwhile the Board has the satisfaction of reporting that the Australian expedition conducted by Dr. Ezer Griffiths and others at the beginning of last year, fully confirmed the ætiology assigned by the Board to the costly "brown heart" disease of apples, and has laid the foundation for elaborating systematic measures of prevention. These are the subject of another recently published report [Special Report No. 20. The Problems of Apple Transport Overseas. By Franklin Kidd, D.Sc., and Cyril West, D.Sc., H.M. Stationery Office; 1*s.* net], and disclose a variety of problems in the ventilation of ships' holds and allied subjects on which a further report is expected at an early date.

BOOKS RECEIVED.

Structural Engineering: Strength of Materials. By G. FILLMORE SWAIN, LL.D. London: McGraw-Hill Publishing Company, Limited. [Price 25*s.* net.]

Scientific Research and Human Welfare. By F. S. HARRIS, Ph.D., and N. J. BUTT, B.Sc. New York: The Macmillan Company. London: Macmillan and Co., Limited. [Price 12*s.* net.]

Problèmes d'Electrotechnique avec Solutions developpées et Applications numériques. By ADR CURCHOD. Paris: Albert Blanchard. [Price 48 francs.]

The British Journal Photographic Almanac and Photographers' Daily Companion, 1925. Edited by GEORGE E. BROWN, F.I.C. London: Henry Greenwood and Co., Limited. [Price 2*s.* net.]

Kelvin Centenary Oration and Addresses Commemorative. London: Percy Lund, Humphries and Co., Limited. [Price 6*s.* net.]

Quatre Conférences sur la Théorie de la Relativité Faites a l'Université de Princeton. By ALBERT EINSTEIN. Paris: Gauthier Villars et Cie. [Paris, 12 francs.]

Sur l'Électrodynamique des Corps en Mouvement. By A. EINSTEIN. Paris: Gauthier Villars et Cie. [Price 6 francs.]

Patents: Invention and Method. By HAROLD E. POTTS, M.Sc. London: The Open Court Company. [Price 3*s.* 6*d.* net.]

The Law Relating to Electric Lighting, Power, and Traction. By the late J. SHIRESS WILL, K.C. Fifth Edition. By JOHN C. DALTON, A.M.I.E.E. London: Butterworth and Co.

Electric Circuits and Installation Diagrams. By W. S. IBBETSON, B.Sc. London: E. and F. N. Spon, Limited. [Price 10*s.* 6*d.* net.]

Aeronautical Research Committee. Reports and Memoranda, No. 916. *Slot Control on an Avro with Standard and Balanced Ailerons.* By F. B. BRADFIELD. [Price 1*s.* net.] No. 923. *Cold Work and Fatigue.* By L. AITCHISON, D.Met., B.Sc. [Price 3*d.* net.] London: His Majesty's Stationery Office.

Department of Scientific and Industrial Research. Radio Research Board. Special Report No. 2. *Variations of Apparent Bearings of Radio Transmitting Stations.* Part I. *Observations on Fixed Stations, February, 1921–March, 1922.* London: His Majesty's Stationery Office. [Price 3*s.* 6*d.* net.]

United States Bureau of Standards. Technologic Papers No. 263. *Tangent Modulus and the Strength of Steel Columns in Tests.* By O. H. BASQUIN. Washington: Government Printing Office. [Price 20 cents.]

MEASUREMENT OF LIQUID FUEL.—At a meeting of the Institute of Marine Engineers in London, on Tuesday, January 6, Mr. Chas. H. Wright read a paper on "Some Considerations in Connection with the Measurement of Liquid Fuel Storage and Liquid Depths." In this, he first described the Pneumercator gauge and then showed its application to service conditions. He then dealt with the simple means available with the system of getting over the difficulties of the use of oils of different densities. Other matters which received consideration by the author were the applications of the gauging systems to dry docks and floating docks for the measurement of the level of the water, the indication, at a convenient observation station, of tidal measurements and the draught of ships, and its use in showing the pressure or vacuum in tanks. Mr. Wright also described a new form of high and low level alarm indicating its use in various types of work.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Stocks of Cleveland pig-iron have been increased over the holidays, but they are stated to be fully sold. Makers are in a strong statistical position, and output is to be increased without delay. Home demand is increasing, and there is some hope of expansion of export trade. A number of home forward contracts have been arranged, some of them being for delivery up to the end of September next, but the sales ahead are stated to have been made at a little below the figures named for early delivery. Sellers still ask up to 86*s.* for No. 1 quality, and 81*s.* for No. 3, g.m.b.; whilst they put foundry No. 4 and No. 4 forge at round about 80*s.*, but offers on lower terms would readily receive favourable consideration.

Hematite.—Notwithstanding the handicap of heavy unsold stocks, the East Coast hematite branch keeps fairly steady, and two additional furnaces are to be rekindled almost immediately. Nos. 1, 2 and 3 are in the neighbourhood of 87*s.* 6*d.*, and No. 1 is quoted at 6*d.* above mixed numbers.

Foreign Ore.—Sales of foreign ore are little heard of, but merchants are not without hope of early improvement, and as a rule they adhere to quotations on the basis of best rubio at 22*s.* 6*d.* c.i.f. Tees.

Blastfurnace Coke.—Durham blastfurnace coke keeps quietly steady, with business on a moderate scale. Good average qualities are quoted 25*s.* delivered here, and several contracts over the first half of the year are stated to have been made at round about that figure.

Manufactured Iron and Steel.—There are no new features of moment in the manufactured iron and steel industries. Common iron bars are 12*l.*; iron rivets, 14*l.* 5*s.*; packing (parallel), 8*l.* 10*s.*; packing (tapered) 11*l.* 10*s.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel ship bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy steel rails, 9*l.*; fish plates, 13*l.*; and galvanised corrugated sheets, 17*l.* 10*s.*

Shipments of Iron and Steel from the Tees.—Shipments of iron and steel from the Tees last year totalled 1,089,483 tons, as compared with 1,109,692 tons for 1923. December loadings amounted to 79,906 tons, 27,805 tons being pig iron, 8,175 tons manufactured iron, and 43,926 tons steel. Of the pig iron despatched, 12,009 tons went coastwise and 15,796 tons went to foreign ports, Scotland being the heaviest receiver with 10,359 tons; whilst Italy took 3,953 tons, Belgium 2,501 tons, Germany 2,183 tons, Sweden 1,765 tons, and America 1,365 tons. Of the manufactured iron shipped, 4,774 tons went coastwise and 3,401 tons went overseas; Natal, with an import of 2,167 tons, was the best customer. Of the steel cleared, 11,018 tons went coastwise and 32,908 tons went abroad, the principal receivers being: India, 7,709 tons; the Argentine, 4,914 tons; Natal, 2,592 tons; Victoria, 2,308 tons; Portuguese East Africa, 2,246 tons; New South Wales, 2,191 tons; Hong Kong, 1,985 tons; and Holland, 1,910 tons.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The more hopeful outlook in the engineering and tool sections is reflected in the increased activity shown in regard to raw and semi-finished materials. Inquiries are in circulation for supplies of pig-iron covering three months' delivery, and the tonnage of hematites being delivered at Sheffield steelworks compares fairly favourably with last year's average. An encouraging factor is that in contrast with values ruling twelve months ago, supplies of iron and steel scrap are available at prices representing reductions ranging from 5*s.* to 15*s.* per ton. Such reductions enable considerable economies to be effected at steel furnaces. New Year quotations show that while hematite values from both East and West Coast producers are unaltered, and similar prices to those ruling in December are being asked for Lincolnshire and Derbyshire foundry iron, reductions averaging 2*s.* 6*d.* per ton have been made in the price of forge iron in an effort to give a further stimulus to buying. Despite the sustained force of Continental competition in mild steel, both hard and soft basic billets produced in Sheffield and district show a rise of 10*s.* per ton. The current list is as follows: Hard basic steel billets, 9*l.* 10*s.*; soft basic steel billets, 8*l.* 10*s.*; West Coast hematites, 5*l.* 5*s.*; East Coast hematites, 4*l.* 10*s.*; Lincolnshire, No. 3, foundry, 4*l.* 5*s.*; Lincolnshire forge, 4*l.*; Derbyshire No. 3 foundry, 4*l.* 2*s.* 6*d.*; Derbyshire forge, 3*l.* 17*s.* 6*d.*; bars, 13*l.*; sheets, 15*l.*—in each case per ton delivered at local works. Satisfactory progress is reported in regard to local colliery developments. At one works there is being installed an exceptionally large gas engine whose main shaft alone is said to weigh 70 tons, while the foundations are stated to contain 6,000 tons of concrete. Steady progress is being made in the production and improvement of rust-resisting metals. Special attention is being paid to malleable material which in sheet form can be easily pressed cold for a large variety of engineering and other purposes. The machine tool trade at last shows signs of improvement. Continental business in high-grade steels is badly hampered by currency differences, though taken as a whole a considerable trade is being done with France and Belgium, and to a limited extent with Germany.

South Yorkshire Coal Trade.—Forward business is gaining force now that the coal trade as a whole has

dispensed with holiday influences. More is being done on home account in best steam hards. Deliveries on export account have fallen into arrear owing to stormy weather at sea. Cobbles and nuts constitute a somewhat more active market, with inland sales of best quality slacks an improving feature. House coal sales have failed to reach their seasonal level, despite a run on merchants' stocks, attributed to recent climatic developments. Quotations:—Best branch handpicked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 20*s.* to 23*s.* 6*d.*; Derbyshire hards, 19*s.* 6*d.* to 22*s.*; Rough slacks, 9*s.* 6*d.* to 12*s.*; Nutty slacks, 8*s.* 6*d.* to 10*s.* 6*d.*; smalls, 4*s.* to 6*s.* 6*d.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—While there are great hopes of a revival in trade during the run of the current year it is very difficult to see any distance ahead in the Scottish steel industry. Producers are well prepared for any sudden call that may be made upon them, but in the meantime the outlook continues rather clouded. The recent change of Government created a certain amount of confidence all round and steel makers were fortunate to secure a number of good contracts, but as the weeks dragged on specifications against these contracts failed to come in, and the works have been carried on in the hand-to-mouth way so common during the major part of 1923. At this time last year the prospects of the industry were also looked upon as good, but the result of the year's working has to be written down as unsatisfactory. Judging from the large increase in shipbuilding on the Clyde during the past year it would have been only natural to expect a corresponding amount of activity in the local steel trade, but a reference to the imports of steel plates, &c., from the Continent at once explains the cause of the lowly state of the local steel works. Imports over all have been about doubled during the year, while our own exports of steel have declined by 35 or 36 thousand tons per month. An average import of about 200,000 tons of foreign steel per month is a very serious thing for the home industry, and is a matter which requires the very careful and thoughtful consideration of all interested—and of our legislators also. The import returns show that over 300,000 tons actually arrived during one month of 1924, and the natural inference is that a similar recurrence is quite possible more frequently unless steps are taken to put an end to it.

Malleable Iron Trade.—The prospect of improvement in conditions in the malleable-iron trade of the West of Scotland in the near future is enhanced by increased inquiries which have been made of late. All the same, there is little to start to when work is resumed, as order books are very bare. A year ago the outlook was also supposed to be better, but nothing came of it, and business was sluggish all through 1924. Much of that unsatisfactory state was due to the severe competition from Belgium, as a large tonnage was dumped into this market at very low prices. Nor does this competition seem over yet, as although the Continental iron is rather firmer it is still below the figure which local producers are prepared to accept. The steel re-rolling departments have been going fairly well recently, but even they have not had a satisfactory year. The general export trade has only been a shadow of former times, but bookings have got rather better, and enquiries point to the prospect of securing some more contracts and a brightening up of the bar iron trade in the district.

Scottish Shipbuilding in 1924.—In a year when unemployment has been exceptionally great all over the country, and when few industries have had anything but a lean time, the shipbuilding returns for Scotland for 1924 are quite remarkable. They show a total increase over 1923 of 144 vessels and 382,505 tons. Two areas, the Clyde and the Dee and Moray Firth, show a tonnage of more than three times that of the previous year, and while the Tay is just under the previous year's tonnage, the Forth is almost double. The following are the figures for the different districts for the past two years:—

	1923.		1924.	
	Vessels.	Tons.	Vessels.	Tons.
The Clyde	128	175,586	251	538,021
The Forth	24	13,426	22	26,051
The Tay	6	23,258	8	20,414
The Dee and Moray Firth	10	4,348	31	14,637
Totals	168	216,618	312	599,123

The indicated horse-power represented by the above totals was 182,506 for 1923 and 473,407 for 1924. The returns for the past year show the Clyde district as an easy first amongst the leading shipbuilding centres. The year 1901 was the first occasion when the 500,000-ton mark was recorded and the past year was the fifteenth time that that figure has been reached. Another fact worthy of note at this time is that the year 1924 makes the eleventh time that over 538,000 tons of new shipping has been launched on the Clyde, and that the past year's output is the eleventh highest on record. The honour of having the largest individual tonnage for the year falls to Messrs. Barclay, Curle and Co., with 11 vessels totalling 70,554 tons, whereas in 1923 the same firm were only twelfth on the list of Clyde builders. The next best return is that of Messrs. Lithgow's, Limited, Port Glasgow, with 16 vessels of 52,046 tons. Of the vessels launched during the past year it is of interest to record that 21 were for motor propulsion, and that these represented 109,623 tons. Amongst these is included the quadruple-screw motor liner Aorangi, of 17,500 tons, which is perhaps the most interesting vessel of the year. She was built at Fairfield for the Union Steamship Company, of New Zealand.

Scottish Pig-Iron Shipments.—The shipment of Scottish pig iron during the week ending last Saturday, January 3, from Glasgow Harbour amounted to 722 tons. Of the total 694 tons went overseas and 28 tons coastwise. For the corresponding week of last year the figures were 810 tons overseas and 20 tons coastwise, making a total shipment of 830 tons.

Quotations.—The new year has opened with nominally no change in prices and the following are the current market quotations:—Steel—boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; sheets, $\frac{1}{16}$ in. to $\frac{1}{4}$ in., 12*l.* per ton; malleable iron bars, crown quality, 12*l.* per ton, all delivered Glasgow stations; Scottish hematite iron, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 12*s.* 6*d.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' works.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The wages of the South Wales colliery workers are to remain at the minimum of 42·22 per cent. above the 1915 standard during the present month. The wages are based on the trading results of the industry in November, when according to the audit of the joint accountants of the colliery owners and the workmen, the certified wages payable were 18·78 per cent. above the standard. The men, however, are guaranteed under the National Agreement a minimum of 42·22 per cent. above the standard, with the result that the owners, in order to pay the difference of 23·44 per cent. are compelled to sacrifice not only their standard profits but also their share of the surplus profits, but, in addition, draw on reserves or increase bank overdrafts. The trading loss in November was 2·46*d.* per ton, compared with 6·74*d.* per ton in October, representing a total loss of 38,614*l.* The output in November was about 220,000 tons less than in October, but the realised pit-head price was increased by nearly 1*d.* per ton, while wages costs were decreased by 2*d.* and other costs by 1*d.* per ton. The latter reductions were fairly accounted for by the fact that the costs of collieries which had been closed for more than three months were excluded from the returns. In the six months ending November there has been a loss aggregating 775,784*l.* In the three months ending November output totalled 11,530,000 tons, or 1,410,000 tons less than in the corresponding period of 1923, while the number of man-shifts worked were also reduced by 1,295,000 to 6,072,000. Meanwhile, new business in the coal market has been quiet, both sellers and buyers following a waiting policy in view of the disorganisation caused by the delay to shipping during the recent heavy gales. Salesmen have been waiting for tonnage to reach port, while buyers have been holding off, expecting irregularity in prices. For spot loading most classes of coal were available at 3*d.* to 6*d.* under the prices quoted for shipment a week or more ahead. Best Admiralty large-ruled round are 27*s.*, with best steam smalls at 16*s.*, and other grades at relative values.

Iron and Steel.—Exports of iron and steel goods in the past week amounted to only 2,135 tons, against 12,872 tons a week earlier. Shipments of tinplates and terneplates totalled 1,339 tons, against 4,044 tons; blackplates and sheets to 351 tons, against 1948 tons; galvanised sheets to 176 tons, against 4,655 tons; and other iron and steel goods to 270 tons, against 2,215 tons. The tinplate market is moderately active, with prices steady at 23*s.* 6*d.* to 23*s.* 7½*d.*

THE TELEPHONE SERVICE.—The Treasury return of national revenue and expenditure for the nine months ended December 31, 1924, shows an increase of 700,000*l.* over the anticipated revenue from the Post Office telephones. The latest P.O. accounts published for the year ended March 31, 1923, show that the Post Office derived a gross revenue from telephones of close on 14,000,000*l.* for the year, and that after all expenses had been paid, including depreciation and interest on capital invested, the net profit to the State was 939,000*l.* for the year. The accounts for the year ended March 31, 1924, are expected to show a net profit of over 1,000,000*l.*

THE BRISTOL "JUPITER" AERO ENGINE.—In our issue of October 17 last, on page 542, we referred to the excellent performance of the Bristol "Jupiter" aero engine in regular service on the Continental air routes of Imperial Airways, Limited. We mentioned that the landing of the machine was such that the engine had to be run at 90 per cent. full throttle, and that it was handled throughout the period by a number of different pilots none of whom had been previously acquainted with the working of this type of engine. When the engine referred to was removed for inspection, a second engine of the same type was fitted to maintain the service, and this second engine, we are informed, has now run for a total period of 157 hours without incident. For 90 hours of the time special observations of petrol and oil consumption was kept, the former averaging 23·9 gallons per hour and the latter 7·6 pints. On one particular day, we understand, the machine was operated continuously for 14 hours, collecting and delivering freight at eight different air ports, the engine functioning perfectly throughout.

NOTICES OF MEETINGS.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—To-night, at 6.30 p.m., at the Engineers' Club, Coventry-street, W. 1. "The History and Evolution of the Avro Training Machine," by Mr. R. J. Parrott.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night, at 7 p.m., at Storey's-gate, S.W. 1. Informal Meeting. "The Maintenance of High-Compression Oil Engines."

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night, at 7.30 p.m., at 39, Victoria-street, S.W. 1. Question and Discussion Evening. Friday, January 16, at 7.30 p.m. "The Hexaphase System and the Compensated Three-Phase System for 150,000 Volts Transmission with Records of Test," by Major A. M. Taylor.

THE INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Saturday, January 10, at the College of Technology, Manchester. "The Making of Thin-Section Patterns for Stoves, Crates, &c., from the Plaster to the Finished Pattern Plate," by Mr. T. W. Markland.

THE INSTITUTE OF TRANSPORT: YORKSHIRE LOCAL SECTION.—Monday, January 12, at 5.30 p.m., at the Town Hall, Leeds. Inaugural Address, by the Chairman, Mr. J. B. Hamilton.

THE INSTITUTE OF SANITARY ENGINEERS.—Monday, January 12, at 7.30 p.m., at the Caxton Hall, Westminster, S.W. 1. Presidential Address.

THE INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Monday, January 12, at 7.30 p.m., at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Open Discussion on "Foundry Costings," by Mr. J. Sterling.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 13, at 6 p.m., at Great George-street, S.W. 1. Ordinary Meeting. Papers to be submitted for discussion:—"The Investigation of the Surge-Tank Problem by Model Experiments," by Professor Arnold Hartley Gibson, D.Sc., M.Inst.C.E.; "The Flow of Water in Pipes and Channels," by Mr. Frank Heywood, M.Sc. Wednesday, January 14, at 7 p.m. Informal Meeting. Subject for discussion: "The Use and Abuse of Reinforced Concrete," introduced by Mr. Henry James Deane, M.Inst.C.E.

THE INSTITUTION OF MECHANICAL ENGINEERS: SOUTH WALES BRANCH.—Tuesday, January 13, at 6 p.m., at the Chamber of Commerce, Adelaide-street, Swansea. Annual General Meeting. Lecture: "Steel Construction as Applied to Steelworks and Mill Buildings," by Mr. A. A. Fordham, B.Sc.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Tuesday, January 13, at 7 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture: "The General Manufacture of Rubber," by Dr. S. S. Pickles.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Tuesday, January 13, at 7 p.m., at the Waverley Station Hotel, Edinburgh. "Automatic and Semi-Automatic Mercury-Vapour Rectifier Substations," by Mr. G. Rogers.

THE MANCHESTER METALLURGICAL SOCIETY.—Tuesday, January 13, at 7 p.m., at the College of Technology. "Tool Steels," by Mr. F. C. A. H. Lantsberry, M.Sc.

THE INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Tuesday, January 13, at 7.15 p.m., at the Hotel Metropole, King Street, Leeds. Address by the President, Mr. W. B. Woodhouse, M.Inst.C.E., M.I.E.E.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, January 13, at 7.30 p.m., at the Rankine Hall, 39, Elmbank Crescent, Glasgow. "The Longitudinal Strength of Ships," by Mr. T. R. Thomas, B.Sc.

THE INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Tuesday, January 13, at 7.30 p.m., at the Armstrong College, Newcastle-on-Tyne. "Brazing," by Mr. A. R. Page.

THE RADIO SOCIETY OF GREAT BRITAIN.—Wednesday, January 14, at 6 p.m., at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. "Some Notes on Short Wave Reception," by Mr. Stanley Ward.

THE INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Thursday, January 15, at 6 p.m., at the Chamber of Commerce, Birmingham. "Arterial Road Construction," by Mr. H. F. Lea.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: BIRMINGHAM AREA.—Thursday, January 15, at 7.30 p.m., at the Chamber of Commerce, New-street, Birmingham. Lecture, "Private Service Motor Body-work," by Mr. Nelson Rowland.

THE INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Friday, January 16, at 7.15 p.m., in the Metallurgical Department, University College, Singleton-park. "Alloys and their Properties," by Professor C. A. Edwards, D.Sc.

THE MANCHESTER ASSOCIATION OF ENGINEERS.—Friday, January 16, at the Engineers' Club, Albert-square, Manchester. "Pulverised Fuel," by Mr. R. Jackson.

THE SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION—Friday, January 16, at 8 p.m., at the Royal Society of Arts, John-street, W.C. 2. Joint Meeting with the Chemical Engineering Group. "The Low-Temperature Treatment of Bituminous Materials," by Mr. T. W. Stainer Hutchins.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, January 16, at 9 p.m. Evening discourse will be delivered by Sir William Bragg on "The Investigation of the Properties of Thin Films by means of X-rays." Afternoon lectures, Tuesday, January 13, at 5.15 p.m., Professor A. Fowler on "The Analysis of Spectra."

COAL CONVEYING PLANT ON THE RIVER TEES AT PORT CLARENCE.

CONSTRUCTED BY MESSRS. HEAD, WRIGHTSON AND CO., LIMITED, ENGINEERS, THORNABY-ON-TEES.

(*For Description, see Page* 40.)

FIG. 7.

FIG. 8.

COAL CONVEYING PLANT ON THE RIVER TEES AT PORT CLARENCE.

CONSTRUCTED BY MESSRS. HEAD, WRIGHTSON AND CO., LIMITED, ENGINEERS, THORNABY-ON-TEES.

(For Description, see Page 40.)

Fig. 1.

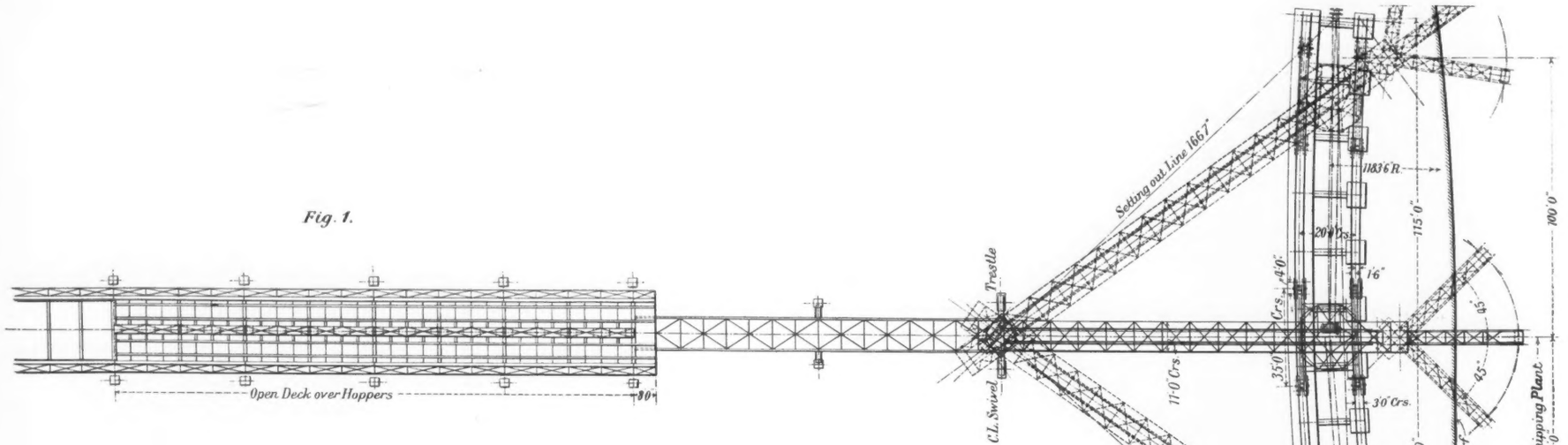
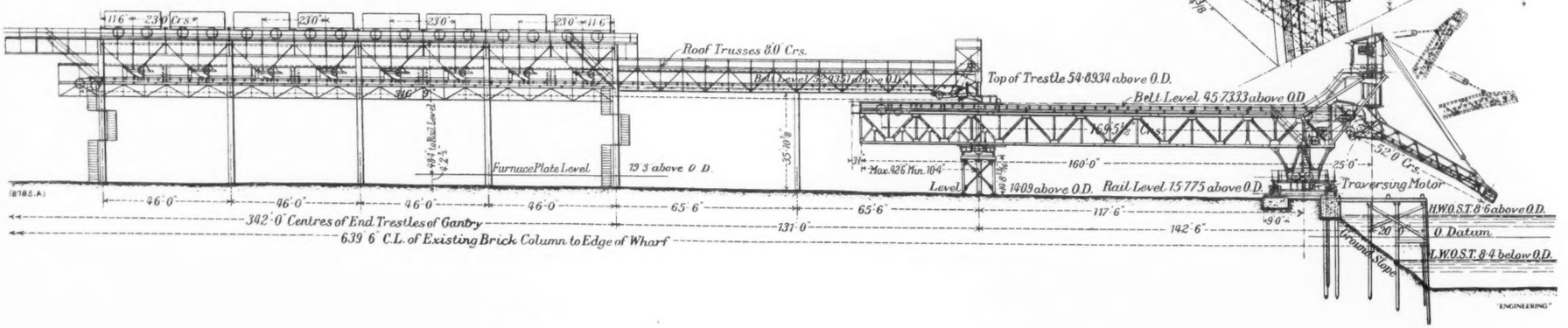


Fig. 2.



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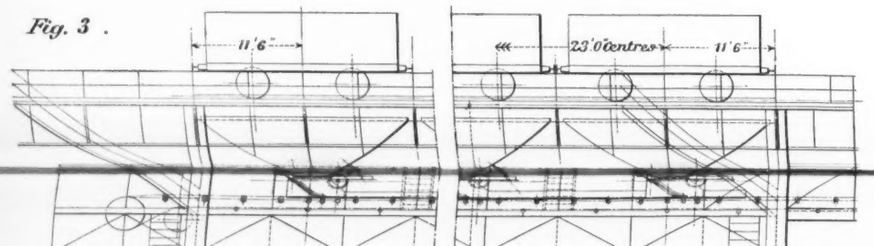

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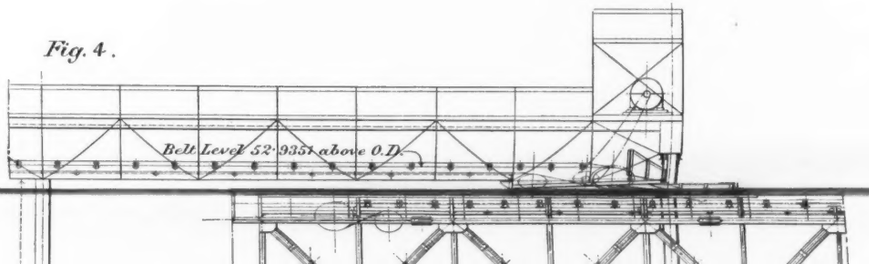
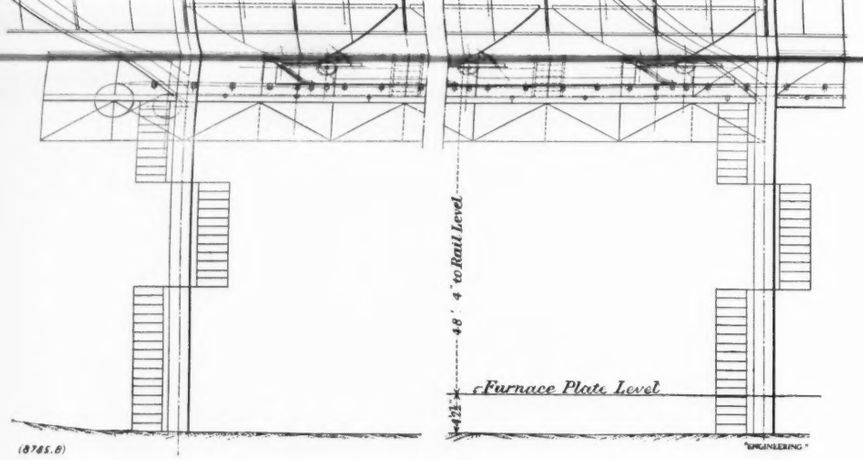
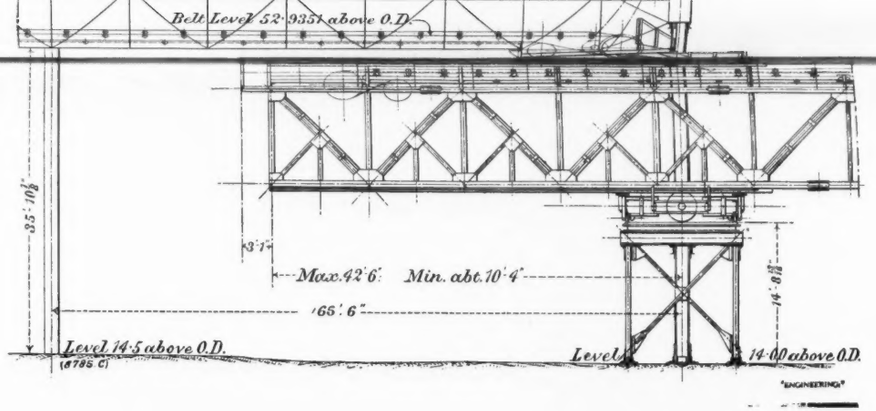



48' 4" to Rail Level
Furnace Plate Level
(8785.B)
"ENGINEERING"


Belt Level 52·9351 above O.D.
35' 10½"
3'7"
Max. 42'6"
Min. abt. 10'4"
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Level
14·00 above O.D.
(8785.C)
"ENGINEERING"

Fig. 5.

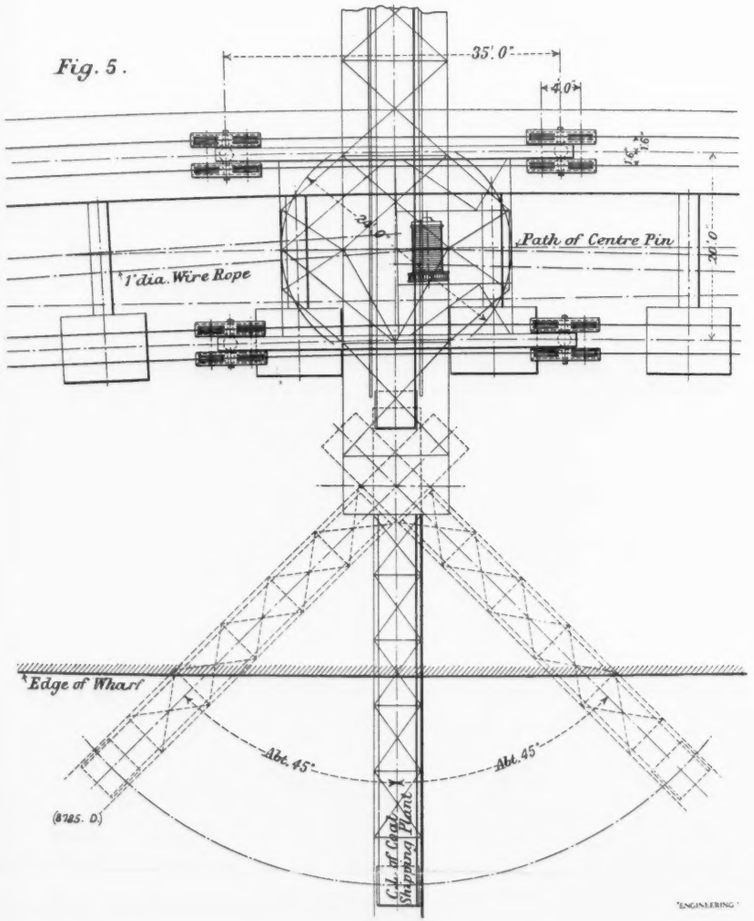
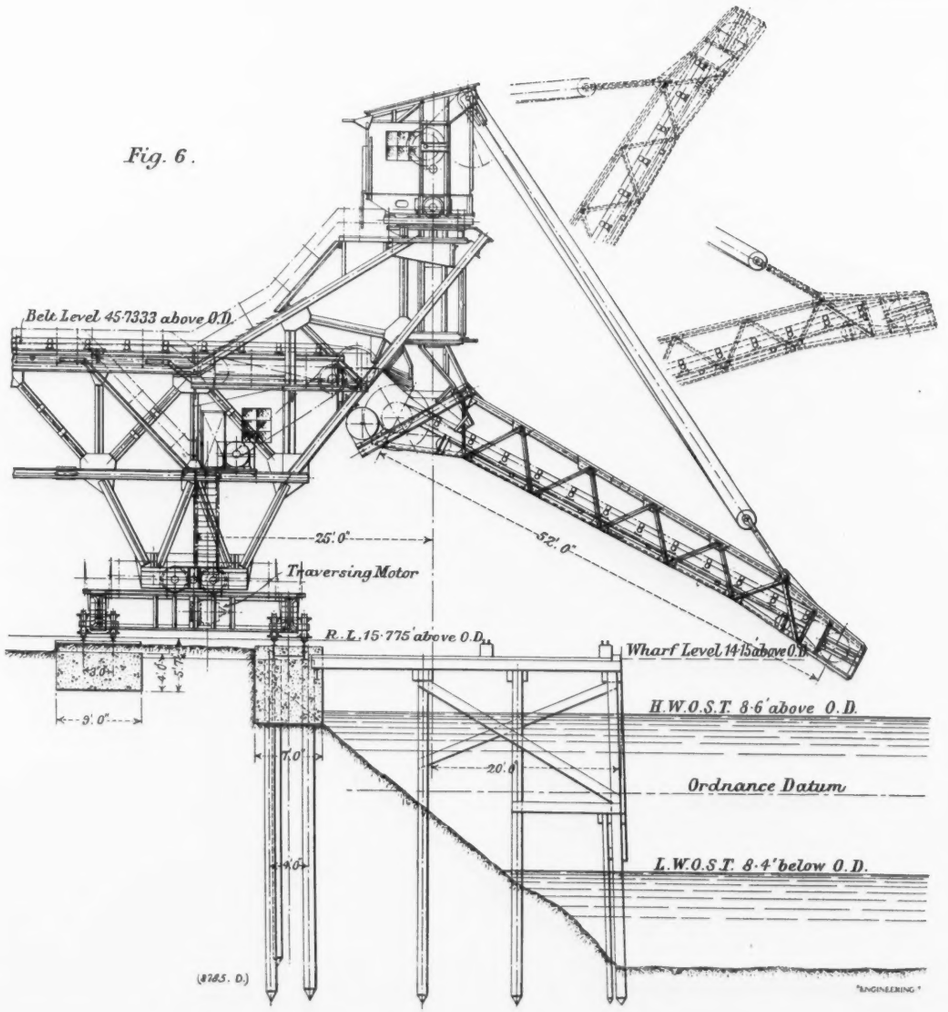

35'0"
4'0"
1'6"
24'0"
20'0"
1" dia. Wire Rope
Path of Centre Pin
Edge of Wharf
Abt. 45°
Abt. 45°
(8785. D.)
C/L of Coal Shipping Plant
"ENGINEERING"

Fig. 6.


Belt Level 45·7333 above O.D.
25'0"
52'0"
Traversing Motor
R.L. 15·775 above O.D.
Wharf Level 14·15 above O.D.
3'0"
4'0"
5'7"
9'0"
H.W.O.S.T. 8·6' above O.D.
7'0"
20'0"
Ordnance Datum
9'0"
L.W.O.S.T. 8·4' below O.D.
(8785. D.)
"ENGINEERING"

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

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Two-Page Plate.—COAL CONVEYING PLANT ON THE RIVER TEES AT PORT CLARENCE.

ENGINEERING.

FRIDAY, JANUARY 9, 1925.

FREEDOM OF INTERNATIONAL TRAFFIC.

AMONG the chief obstacles to the welfare of the world is the viscosity of wealth. In the conditions of modern life every country needs the products of others, and for many countries prosperity is restricted, not because they do not get enough out of the earth, but because what they and others get from it flows too slowly enough from where it is to where it is needed. More than one set of circumstances may be at work to cause this viscosity. Fluctuations of exchange, for example, customs tariffs, shortness of labour or of capital, may each or all affect it at one time or another; but what at all times is an essential factor in reducing it is a sufficient supply of transport. Freedom, therefore, of international traffic is an indispensable condition of world prosperity; and it would be an evil day alike for this country, with its settled policy of avoiding the imposition of customs tariffs wherever trade can be done without them, and for those countries that do business with it either as customers or as suppliers, if it were compelled to take any measure that restricted the free passage through its ports of the flags of all countries.

At the present time this is the practically unanimous conviction of the commercial bodies of all countries, and if their opinion is allowed to determine the action of their States, industry throughout the world may look forward to remaining free from artificial impediments to its transport service. The recent history of international transportation and its immediate prospects of freedom and coordination were discussed broadly in the paper read on Monday last by Brig.-Gen. H. O. Mance before the Institute of Transport, in which in particular the author summarised its development since the war, and the particular aspects that are still waiting international attention. Perhaps the most notable feature of this development, as of many other movements affecting all civilised countries, is the increasing extent to which attempts are made to arrive at bases applicable to and accepted by the entire world. Such conventions have not been unknown in the past, though as a rule they have existed in virtue of the proceedings of private representative bodies, such as the International Law Association, which drew up the York-Antwerp rules of general average, or combinations of them, such as the British Chamber of Shipping and the Baltic and White Sea Conference, which virtually settled the approved form of charter. The proceedings of such private bodies, informed as they are by the transactions of professional associations such as the International Railway Congress and the contents of the technical Press, take due account of the latest stage of technical practice, and are addressed necessarily to such matters as for the time being may be of the chief interest to the groups that these bodies represent. Their resolutions are inspired by needs already felt by their constituents, and when these constituents do not represent all countries or are dealing with matters that for the time being interest only some countries, their action may constitute the thin end of the wedge, and tend to become generalised more readily than if the development had been attempted by means of a parallel drift.

General Mance remarks as "somewhat curious" that a fairly liberal régime of international traffic was built up by commercial treaties without the help of general principles of international law, and records that since the war it has been found indispensable to elaborate certain principles for general acceptance, which presumably will have to be added to from time to time. The regulation of economic and commercial problems by such general principles is doubtless a more ambitious scheme than the previous method of evolving them by levelling up voluntarily from time to time to the standard of the best practice. If it is successful it will effect more than could have been done by the older and simpler method, and all who are interested in industry will feel the most sincere wish for its success whenever it is applied. With due weight paid to practical as well as theoretical considerations, there is no reason why many general propositions of universal value may not be added to the slender code that regulates international trade, and particularly its transport. In addition to the private bodies mentioned above there are the recently created International Railway Union, the Comité Maritime Internationale of Brussels, the International Shipping Conference formed in 1921, and the Sea Transport Committee of the International Chamber of Commerce created in 1920. For any purposes, however, for which international State agreements may be thought desirable it seems probable that instead of adopting the previous practice of convening a diplomatic conference through the Belgian Government, the machinery of the League of Nations will more often be invoked, the Transit and Communications Section of which has already shown much activity.

The League has facilities for bringing together any particular class of experts from all over the world, and conferences convened by it have been able to arrive at practically world wide agreements in a few days—thanks to the considerable volume of preparatory work done by the Secretariat—which in General Mance's judgment might have taken years to arrange without it. The General Conference, for example, on Communications and Transit held at Barcelona early in 1921, and the second Conference on the same subjects held towards the end of 1923 arrived at a number of practically unanimous resolutions in regard to the working of ports for international traffic, and other subjects of fundamental importance to the transit service. Those to whom these resolutions are not familiar will read General Mance's extracts from them with interest, and will see with him that they indicate distinct advance in the direction of forming an international public opinion on matters of common economic interest, and an increasing disposition to adopt measures of automatic reference of disputes to arbitration or some equivalent process, in particular to submit such disputes as may arise to the Permanent Court of International Justice established in connection with the League. The dangers, of course, of concentrating on world-wide agreements, apart from the increased risk of failing to reach agreement,

are on the one hand that they are apt to assume an expression too generalised and theoretical to be likely to wear well in practice; and, on the other hand, that, in order to reach a universal agreement, compromises may be adopted which leave arrangements less effective than might have been made had fewer States been concerned. The subject of international traffic has, however, so many technical aspects that the risk of substituting sonorous generalities for practical provisions is less than it may be in other departments of social activity, and there seems no reason for dissenting from General Mance's conclusion that the League, with the co-operation of the many representative bodies that are in a position to place authoritative views and evidence before it, may succeed in developing its practice on lines satisfactory to all countries.

Ultimately, however, each of the constituent States will have a several voice, which will not necessarily be overborne by the opinion of the majority, and it is therefore earnestly to be hoped that both the conclusions of League Conferences and public opinion in the several States may take constant heed of the simple economic facts on which international traffic must be conducted. A disposition is seen sometimes to use national transport services as weapons to support each other or other national industries. At the present time, for instance, it seems uncertain whether the United States may not adopt legislation requiring a certain proportion of immigrants to be carried in American bottoms, and compelling railway companies to grant preferential rates to goods destined for shipment by them. In the long run, doubtless, whatever cost may be involved in such measures will be paid by the United States itself, but the measures will nevertheless be mischievous to the trade of other countries, such as our own. They amount, in effect, to indirect taxation, as contrasted with the direct taxation imposed by a tariff. For the internal fiscal system of a country indirect taxation has great advantages; nobody who has an income likes an income tax. For merchandise and, in particular, for exported merchandise, the use of indirect taxation introduces a complication which tends covertly to depress trade beyond the restriction created by a tariff; and for services, such as transport, the reduction in facilities that indirect taxation effects creates a direct impediment to the flow of trade in each direction. Each State must judge for itself what customs tariff best suits its interests, but up till now it has been the practice to place at the disposal of traders on each side the most ample transport service all countries can produce. It is earnestly to be hoped that this practice will be maintained. It is one in which our own country is vitally interested, and a serious attempt to depart from it could not be viewed with indifference in conmercial circles on either side of the Atlantic.

PATENT PRACTICE.

SEVERAL decisions have recently been given by the Patent Office Authorities, or the Law Officers of the Crown, which indicate the trend of modern practice in the Patent Office with respect to the allowance of patents on matters which show either only a small advance in an art or which do not deal with the production of a commercial vendible article. The Statute of Monopolies, on which the Patent Law is based, makes it clear that a patent may only be validly granted for a manner of new manufacture, and as the right is given by the Crown under the Statute that the patentee shall have the sole liberty to make, use, exercise and vend the matter patented, it is generally accepted that what is patented itself must be vendible or, if it be a process, that it must result in a product which is vendible. The Patent Office has at all times, therefore, tacitly been given the power to consider whether the specification placed before them as the basis of the grant, is one which leads to the production of a vendible article, but practice shows that from time to time the method of utilising the power thus held has varied.

Until 1905, no search among prior patents was made by the Patent Office, so that no patent could be refused on the ground of want of novelty, but the specification strictly had to disclose something from which a manner of manufacture could result. Even now, notwithstanding the recent Act of 1919, the Comptroller has only power to refuse the grant of a patent on certain well-defined grounds, which, assuming that the patent is not for an illegal purpose, may be summed up by saying that the invention must be wholly and specifically claimed in some other patent specification. When a patent is granted and is tested in Court, much more severe attacks can be made on it, the common attack being want of subject-matter, that is to say, lack of such ingenuity as amounts to invention in arriving at the patented process or article, having regard to what has previously been available in practice or in literature in the art itself. The result of this is that a large number of patents have been granted for very small advances or differences in the art, because the Patent Office has not had power to refuse the grant, owing to the definite grounds alone open to the Comptroller as the basis of refusal.

Examiners appear to have felt that in their investigations they ought legally to be entitled to consider the advance made in the art, that is to say, whether there is subject-matter for invention or not. This is done in certain foreign countries, for example, in the United States of America and in Germany, but this has been definitely withheld from the powers given to the Comptroller and his Examiners in this country. The way in which the matter seems now to be viewed in the Patent Office is that although subject-matter as such may not be argued with an inventor, the Patent Office may take the attitude that when what has been known by means of the prior art is subtracted from the alleged invention, there may be nothing of substance which can be called a "manner of manufacture." It is for this reason that inventors for some years have now frequently been met with the objection that the specification does not appear to cover any patentable manner of manufacture, and considerable difficulty has frequently been found in overcoming this objection.

Decisions are given from time to time by the Solicitor-General on the effect of particular cases before him, which are useful in indicating to inventors generally the view held by the Patent Office Authorities, and, therefore, the following decisions recently reported are of interest. They all refer to matters in which the grant of a patent was refused by the Law Officer, the first two being the ordinary application proceedings and the last two cases in which opposition was raised after the Comptroller had accepted the specification.

In the first case the application for protection was for a process of staking out a route by means of so-called "phonic cables," permitting movable objects to locate and place themselves in direction and distance relatively to the route by means of sound emitters. The essential feature of the invention was that, instead of sending into the cable a single current for operating the sound emitters, two separate currents were used, one a direct current which effected the operation of the sound emitters and the other a variable current either direct or alternating for forming a magnetic field. According to the Solicitor-General, the substance of the claim appears to be not in the nature of an invention, but merely the discovery of a more expedient method of operating an old device, and the law applicable thereto, as far as the Patent Office is concerned, in his view, is that covering an earlier decision of an application of which the basis was the discovery that a direct current would produce a better result than an alternating current in connection with a certain filament. The Comptroller refused to accept the specification because he held that it related to a method of navigation rather than to a manner of manufacture, and that the mere new use of known apparatus for a purpose which has no connection with manufacture does not satisfy the definition of an invention. The Law Officer held that the Comptroller was right and refused to accept the specification.

In the second case the matter in question also related to route-indicating phonic cables. The Examiner and the Supervising Examiner acting for the Comptroller-General refused certain claims which were drafted as claims to methods, but in this connection it is important to note what was said in the decision, namely, to say that a method or process of observation or test is necessarily excluded from the field of patentable invention because no tangible product results from it, would be too sweeping a statement. Patents have been granted for methods of testing electrical machinery, testing electrical insulators, testing the hardness of metals and so forth, and, provided that the methods claimed necessitated the use of novel combinations or arrangements of apparatus, and that the tests can be regarded as applicable in guiding and controlling manufacturing processes, it has not been the practice of the Patent Office to reject such claims. This decision was not reversed by the Solicitor-General, and probably for the first time it clearly expresses the Patent Office view of specifications submitted to it which relate to tests. The Comptroller-General found that the particular methods in question did not fall within this definition and refused the grant, the refusal being confirmed by the Law Officer.

In the opposition cases to which reference has been made above, an important new point appears in that two publications seem to have been taken together as a ground of objection to the patent. Apparently there must be some particular reason for this in the case in question because it has been generally held that a mosaic of prior documents may not be made to defeat a patent. The specification in question was accepted by the Examiner, who could not in the nature of things have had either of the references officially before him and, although these were subsequently considered by the Comptroller-General, he decided to seal a patent. With this view the Solicitor-General did not agree and refused the patent. The invention related to cylinders of oil engines, the claim involving an internal-combustion engine with ignition by the heat developed due to the compression and characterised by a combustion chamber formed with successively increased axial length from the centre towards the periphery, and further characterised by the injection of the fuel into the chamber at the narrowest portion by outwardly directed jets of a particular type. A book was adduced in evidence which contained a large amount of material on the subject in question and, further, a drawing was produced showing the employment of certain jets, as a result of which the Solicitor-General found that, after eliminating what was known, no minimum of invention was left.

In the next opposition case, dealing with the protection of electric lamps made of opal glass, it was pleaded that, whereas the melting of two layers of glass together—one clear and the other opalescent—was well known and familiar in the case of vacuum lamps, there was a definite problem involved in gas-filled lamps because of deterioration which took place. The Law Officer found that this was not supported by evidence, but that at the most there was here merely a selection from earlier discoveries. This point is also important to inventors because it is commonly thought that a selection may well form the basis of a patent grant. The test now applied appears to be that this selection of itself is not sufficient, but that there must be a selection for a particular object properly defined, or a selection which itself involves invention. The decisions heretofore have to a certain extent appeared to be conflicting, but the modern tests tend in the direction indicated.

THE ALUMINIUM ALLOY ALPAX.

THE production of castings of aluminium alloys of high tensile strength is a question which has exercised the minds of non-ferrous metallurgists for many years. Many light alloys which yield excellent mechanical properties in the rolled or forged condition do not cast satisfactorily. On the other hand, those aluminium alloys which produce good castings often give only moderate mechanical results. The alloy Alpax (86·5 per cent. Al, 13·5 per cent. Si), recently introduced by Dr. Pacz, of Cleveland, Ohio, would therefore appear to occupy a

specially useful field since not only are its mechanical properties in the "as cast" state remarkably good, but it also combines a very low density (2·5 to 2·65) with a relatively small solidification shrinkage, the latter being of the order of cast-iron. Experiments show that the properties of cast Alpax are better than those of the rolled and annealed material. This curious exception to the general metallurgical rule seems, so far, to be unexplained and will, no doubt be the basis of further research.

A comparison of the mechanical properties of various cast light alloys shows that Alpax possesses exceptional qualities. Whereas the tensile strength of cast Alpax lies between 11·4 and 14·6 tons per sq. in. (with a general average of 13 tons), that of cast 92 : 8 aluminium-copper is between 7·7 and 9·5 tons, and that of cast 88 : 2 : 10 aluminium-copper-zinc between 7·7 and 10·8 tons. The figures for elongation per cent. are, respectively, 5 to 10, 1 to 2, and 2 to 4.

Referring to the new alloy, M. de Fleury, the French metallurgist, who has been engaged in the production of Alpax castings, made the following interesting statement at a congress of foundrymen held at Nancy in 1921: "If Duralumin is to aluminium what forged steel is to soft iron, Alpax is to cast aluminium what cast-steel is to cast-iron."

From a scientific as well as from a practical aspect the refining of Alpax is of great interest, and is fully brought out in an able paper by Professor Léon Guillet entitled "Un Nouvel Alliage d'Aluminium : l'Alpax," translated into English, Mr. R. J. Anderson, and considered recently by the American Foundrymen's Association. Aluminium-silicon alloys have been known for many years, but, at the same time, the special refining process introduced and patented by Dr. Pacz is new, and is of considerable importance as being something of an innovation in the metallurgy of aluminium. Briefly, this consists of adding alkaline fluorides to the melt in the crucible, stirring, and skimming off the slag. This process has the effect of changing an unsatisfactory alloy of relatively poor mechanical properties into one possessing high tensile strength, good elongation, and great toughness. We need not enter into the actual chemistry of the refining process, which, at best, is somewhat obscure, but it is interesting to note that, although aluminium is used to a considerable extent as a deoxidiser for other metals (steel, for example), the question of a deoxidiser for aluminium itself has long been a matter of difficulty.

One of the first points raised when a new alloy of aluminium is being discussed is with regard to its resistance to corrosion. This subject has not been neglected by investigators, and, although data are none too plentiful, it is stated in Professor Guillet's paper that the resistance of Alpax to corrosion by sea water is "particularly high" and, in this matter, "presents a real superiority over other aluminium alloys." This is distinctly encouraging and, if fully borne out, will undoubtedly do much to enhance the value of the material under discussion.

Although Alpax appears to have been definitely adopted on the Continent and elsewhere, further research would be likely to prove profitable. Apart from the necessity of elucidating various problems dealing with the casting of the alloy, it is very probable that its possibilities are by no means exhausted and that further investigation may well bring out properties still more remarkable than those already known. The thermal equilibrium diagram of the binary system aluminium-silicon has been fairly definitely established, but there are several problems connected with it awaiting solution. There appears to be some discussion about the correct position of the eutectic point, and, although a slight difference in eutectic composition would not have any appreciable effect on casting conditions, this serves to show that the systematic study of aluminium-silicon alloys is only just beginning.

Little attention seems to have been paid to the impurities commonly present in commercial aluminium, notably iron, but it would seem that the presence of the latter in a casting does not have the deleterious effect which it undoubtedly exerts in metal used for spinning and stamping.

The progress made in the successful casting of Alpax will be watched with interest by foundrymen the world over. The investigators are, rightly, very enthusiastic, and consider that the new alloy is destined to occupy an important place in the motor-car, aeroplane, and similar industries. Industrial castings have already been made, notably for motor-omnibus parts, and seem, so far, to have proved satisfactory. M. de Fleury has gone to the extent of stating that, in his opinion, castings of Alpax will gradually replace steel castings wherever lightness is the first consideration. The verdict of the mechanical engineer will, of course, only be finally given when castings of the new material have stood the test of time and have proved themselves superior to the class at present in use.

METROPOLITAN RAILWAY IMPROVEMENTS.

AN important stage in the development of the passenger transport facilities of the large residential area of Middlesex and Hertfordshire lying to the north-west of London, was reached on Monday last, when, by the completion of the newly-electrified section of the line between Harrow and Rickmansworth, the Metropolitan Railway Company was able to commence a regular service of electric trains between Baker Street and Rickmansworth. As our readers are doubtless aware, the Metropolitan Railway system now extends from Baker Street to Verney Junction, with branch lines to Brill, Chesham and Uxbridge. The Uxbridge line branches from the main line at Harrow, and, together with the Baker Street-Harrow section of the main line, part of which is underground, has been operated electrically for about twenty years. As it was obviously undesirable to employ steam locomotives on the underground section of the line, it has hitherto been necessary to stop all main-line trains at Harrow for the purpose of replacing the electric locomotive by a steam engine. This stop will now be rendered unnecessary, and the consequent time-saving, in addition to that resulting from the more extended use of electric traction, will enable a great improvement in the service to be effected.

With the 1,200-h.p. Metropolitan-Vickers electric locomotives used on the system, one of which was illustrated and described in our issues of April 7 and 21, 1922, on pages 409 and 477, respectively, the journey of 17½ miles between Baker Street and Rickmansworth will be covered by non-stop trains in 25 minutes. The newly-electrified section has a length of 7½ miles, and is, of course, operated on the same system as the remainder of the line. Power is supplied from Neasden power station at 11,000 volts to new sub-stations at Northwood and Rickmansworth, where it is transformed and converted into direct current at 600 volts for feeding the conductor rails. Two of the latter, weighing 120 lb. per yard, are used for each track, the negative rail being located midway between the running rails and the positive rail being situated outside. The new sub-stations each contain three 1,200 kw. Metropolitan-Vickers rotary converters, and the capacity of the previously-existing sub-station at Harrow has been increased by the installation of an additional 1,500-kw. rotary converter of the same type.

Automatic signalling by the Westinghouse Brake and Saxby Signal Company, Limited, is employed, the signals being of the three-colour light type. It should also be mentioned that the traffic beyond Harrow will be further facilitated by the completion of a burrowing junction at that town, to take the Uxbridge branch line under the main line, thus avoiding interference with the latter. Work on the junction is now making good progress. Another matter of interest in connection with the system is the construction of a branch line, about 2½ miles in length, between Rickmansworth and Watford. This line is being constructed jointly by the Metropolitan and London and North-Eastern Railways, and it is expected to be completed in a few months' time. A northern spur and junction are being provided to connect the Watford branch with the main line, so that a shuttle service may be worked to and from Rickmansworth, as well as a through service.

NOTES.

ELECTRICITY SUPPLY UNDERTAKINGS.

ALTHOUGH there are more than one unofficial publication which give particulars of the various electricity supply undertakings in this country, there is much gain in an official return, which may be presumed to be both more accurate and more complete than privately compiled returns can well pretend to be. Such an official publication has been prepared by the Electricity Commissioners and has just appeared under the title "Electricity Supply Undertakings: Return of Authorised Undertakers in Great Britain and Administrative Particulars of Undertakings at December 31, 1923." This publication runs to a total of 378 pages, and contains a really remarkable amount of information. It illustrates, probably more clearly than any other document we have seen, the complexity and magnitude of the task which has been set to the Electricity Commissioners in bringing some coherence and unity into the widespread and important public service with which they are concerned. As will be gathered from the title this return is concerned with administrative particulars rather than technical ones, so that to a very important extent it does not cover the same ground as some well-known annual publications, which are likely to remain of more value to most engineers. The information given refers to authorisation, area and date of commencement of supply, undertakers, populations served, and information in reference to charges, bulk supply rights, &c. The work is of such size and completeness within its own sphere that we are not surprised to learn that it is likely to be re-issued only at infrequent intervals. The Commissioners, however, have under consideration the question of issuing supplementary returns at periodic intervals so that the information available may be kept as nearly as possible continually complete and accurate. The volume may be obtained from H.M. Stationery Office at any of the usual addresses or by post for 10*s.* net, which does not include postage.

VISIT TO ENGLAND OF SOUTH AFRICAN ENGINEERING STUDENTS.

It has frequently been contended that the representation of Home firms in the overseas Dominions and Colonies would be greatly strengthened, and increased business would be done, if men from these territories could come here and be trained in the works and then go out again with a full knowledge of the outlook and methods of the firms concerned, as well as a complete understanding of the characteristics of the people from whom they solicit business. There can be little doubt that, if suitable men are obtained, this method will produce good results and it is, therefore, of interest to the manufacturers of Great Britain who hope for business in the future in South Africa, for attention to be called to the fact that thirty-two undergraduates in engineering of the University of Cape Town are now making a tour of British factories, power stations and technical institutions. An enterprise of this character should receive every encouragement and we hope facilities will be extended to this party in all directions. The party arrived in London on Wednesday, December 31, under the direction of Professors McMillan, Bohle, Snape and Plant. After visiting many of the works of the leading concerns in London, they will proceed to Birmingham, Manchester, Preston, Sheffield and Newcastle-upon-Tyne, where they will be able to see something of the modern methods of the companies with whom, in the future, they may have closer relationships. Of the young fellows who compose this party there may be many who are suitable for training for the express purpose of future employment in the Union as representatives. Whether this be so or not it must be greatly to the benefit of the young engineers of South Africa to see the thoroughness with which the problems of design and construction of engineering plant are being solved by British engineers. It should be added that the cost of this unique enterprise has been kept down through the generous concessions made by the Union Castle Steamship Company and the English railway companies, while Messrs. Merz and McLellan are to act as hosts to the party

when they visit Newcastle-upon-Tyne. Many Universities, City Councils, Chambers of Commerce and individual firms have also, we are glad to note, arranged receptions and other social functions for the entertainment of the visitors.

Automatic Telephony.

In his presidential address, delivered last Wednesday to the Junior Institution of Engineers, Dr. A. Russell gave some particulars of the work of converting the manually-operated telephone system of London into an automatic switching system. This is now well under way, but it will take some fifteen years to complete. The change is an eminently desirable one for social as well as for economic reasons, since it is difficult to imagine a more uninspiring daily routine than that of the switchboard attendent, and is highly desirable that whenever tasks of this kind can be efficiently executed by mechanism, the human factor should be eliminated and transferred to some occupation less devoid of intellectual interest. Dr. Russell states that the accuracy of the service at a telephone exchange depends largely on the subscribers themselves. Delays, he pointed out, are often due to a lack of clearness in articulation, and it may further be added that as two human factors are involved the chances of error are doubled. The automatic exchange is, as Oliver Wendell Holmes said of the calculating machine, "too stupid to make a mistake," and hence, such errors as do arise will be the fault of the subscribers alone. One great advantage of the automatic system will be that the service at night will be as good as during the day. Dr. Russell also referred to the method of "teletyping" which is now being provided in the United States by the Western Union and the Bell Telephone Companies. A description of this was given on page 4 of our last issue. With this system in question an ordinary girl typist will be able to type messages given as much as 5,000 miles away from her, at a speed of at least 30 words a minute. Dr. Russell stated that our own post office is already using the system on several long lines, but the Americans plan is to extend the system to private individuals.

The Shipbuilding Industry.

In the shipbuilding returns for the quarter ending December 31, 1924, just issued by Lloyd's Register of Shipping, the figures compared with those for the preceding quarter are rather disappointing. The work in hand has decreased by 171,437 tons to 1,296,971 tons for the total tonnage under construction in Great Britain and Ireland. This decrease, however, is partially offset by the fall in the tonnage on which work had been suspended to 60,000 during the last three months. An important factor in any review of the situation is the amount of new tonnage laid down during the same period, and in this connection the record shows a fall of 58,151 tons to the disadvantage of the later return. With regard to the tonnage launched, however, the outlook is more satisfactory, 352,629 tons being included in this class for the last quarter of the year 1924, or only 7,590 tons less than the corresponding figure for September. The current tonnage being built includes 286 vessels of which 230, making a total of 976,134 tons, are steamers, and 50, with a tonnage of 320,137, are motorships. Sailing vessels building only number six, which have an aggregate tonnage of 700, included in the total. The proportion of motor tonnage to steam tonnage of ships has increased from 23 per cent. at the beginning of last year, to 32¾ per cent. at the end of the year. Merchant tonnage to the amount of 1,173,465 tons is being constructed abroad, comprised in 370 vessels. This is an increase of 61,000 tons compared with that being built at the end of September last, and 126,310 tons greater than the figure for the end of the year 1923. The present position with regard to foreign shipbuilding, in general, is relatively better than our own, though in the case of Germany inferior to her results of a year ago. The new tonnage laid down abroad reached 290,601 tons in the quarter ended December, whilst 194,356 tons were launched, an increase respectively of 12,513 tons and 1,984 tons compared with the corresponding figures for the quarter ending in September last. Almost a third of the total tonnage under construction abroad continues to be built in German yards, the tonnage for that country amounting to 355,250. Important contributions are those of France with 197,170 tons, Italy with 154,790 tons, and Holland with 124,766. The United States have now only 58,174 tons in hand, comprised in 27 ships, a further reduction in the tonnage being constructed, compared with statistics for the same period in the year 1923. Altogether the foreign returns generally reflect the more stable business position obtaining throughout the world during the past year, compared with the immediately preceding period. The home industry, on the other hand, is experiencing slackness of trade brought about by low freight rates and high prices of construction.

Behaviour of Lubricating Oils under Test.

Oil testing is empirical and only partly satisfactory, because oil does not keep its original properties when serving as a lubricant. The changes are due to various causes. Oxidation is, no doubt, one of the chief factors; heat and the introduction of impurities are other causes. Why Mr. J. B. Hoblyn, F.I.C., A.R.C.S., should have adopted the title, "The Behaviour of Lubricating Oils Under Oxidising Tests," for a paper, read before the Institution of Petroleum Technologists on January 6 is, however, not evident. The title implies special oxidising tests, but there was no mention of such tests in the paper at all, and if the heat tests he did perform were to involve oxidation, as they probably did, we should be entitled to look for chemical evidence of oxidation, which was not given. Some time after use, Mr. Hoblyn pointed out, all lubricating oils on the market began to form asphaltenes which are insoluble in petroleum ether; but he did not attempt to define that term chemically. Heated for a long time, in test or service, they further showed carbenes, matters insoluble in carbon tetrachloride, of the nature of a "product close upon the heels of elemental carbon." Oils which quickly formed asphaltic bodies were found to be of low flash point, and with such oils the quick decomposition of the oil in the crankcase of a motor-car, which frequently caused trouble in starting on cold mornings, was accompanied by a partial distillation of the oil, some of the more volatile constituents recondensing on the sparking plugs. An oil that lost least in the heat (evaporation) test would yield the best results. Two oils, of almost the same viscosity, density, open flash-point and setting point, giving also practically the same evaporation curves, had yet proved very different in heavy motor service; one proving satisfactory, while the other turned dirty and gelatinous in the crank case, the tappets becoming sticky, and a good deal of carbon being deposited on the pistons. A difference in the oils was shown by the sludge test, the two values being 1·97 and 0·53 per cent. of sludge. The bad lubricant began to show signs of decomposition after heating to 250 deg. C. for 16 hours, whilst the other stood that heat for 36 hours without decomposition. Another oil looked in the crankcase "like an asphalt pavement on a summer's day" after 500 miles' car run, and was found to consist of 52·3 per cent. of oil, 8·7 per cent. of asphaltenes and 36 per cent. of carbenes. The falling out of asphaltenes seemed to be the first sign of decomposition. In one case Mr. Hoblyn observed after two hours' heating to 250 deg. C., no soft asphalts, 0·27 per cent of asphaltenes and no carbene; after 28 hours the corresponding figures were 2·96, 30·1 and trace; after 32 hours 3·02, 26·4, 3·32, and after 40 hours 3·28 per cent. of soft asphalts, 25·9 per cent. of asphaltenes and 7·85 per cent. of carbenes. It would then appear that these products undergo progressive changes, and these changes might lead to seizure in a bearing even in the absence of worn metal or road dirt or any stoppage of the oil flow.

Demonstration of Treating Steel by Heat.—The B.S.A. Tools Company, Limited, will give a demonstration of automatic hardening in a Wild-Barfield electro-magnetic furnace at the Birmingham Corporation Electrical Showrooms, 21, Paradise-street, Birmingham, throughout the week commencing January 19, 1925.

YEAR-BOOKS AND ANNUALS.

Mechanical World Year Book, 1925.—The usefulness of this pocket book and diary has been increased in each year of its publication, and it was originally issued 38 years ago. Its value must not be estimated on the basis of its low price, 1*s.* 6*d.* net, for the tables it contains are those most wanted by engineers, and the notes on points in design of a great variety of plant, are thoroughly well done. A new section has been added relating to "Surface Condensers for Steam Turbines," and another new feature is the inclusion of some useful information on "Foundations for Machinery." A chapter of value is the one on "Notes on Foundry Works." Many revisions have been made, and the year book for 1925 may be recommended as an eminently practical handbook. The publishers are Messrs. Emmott and Co., of 65, King-street, Manchester.

Calvert's Mechanics' Almanac, 1925.—This annual publication contains not only many of the usual tables of physical constants, standard sizes, &c., but it has the distinguishing characteristic of giving a series of practical hints for use in the workshop, every one of which is worthy of the close attention of apprentices and young mechanics. It is, perhaps, the cheapest year-book available, as it is sold at 6*d.* net. The notes it contains were selected and edited by Mr. Frank Nasmith and Mr. Frederick Poulton for the publishers, Messrs. John Heywood, Limited, Manchester. Perhaps, in future editions it may be thought advisable to give a table of properties of steam which starts below the absolute pressure of 65 lb. per square inch and which gives the volume of a pound of steam at various pressures in keeping with the results of recent investigations. We have no hesitation, however, in recommending the Almanac to all young engineers in the workshops.

The Practical Engineer Electrical Pocket Book.—This well-known pocket book and diary has now reached its twenty-sixth year of issue. It is published by Mr. Humphrey Milford at the Oxford University Press, Amen House, Warwick-square, London, E.C. 4, and is sold bound in cloth at 2*s.* 6*d.*, and in leather cloth at 3*s.* The volume, which was edited by Mr. Conrad Arnold, A.M.I.E.E., contains 674 pages, and information is given in it on almost every type of electrical plant. Because of much of this matter the pocket book is to be recommended, but it has a weak spot, which must be commented on. Pocket books are often consulted for wiring rules, and if this publication is used for the purpose troubles will be experienced. The reason is that the old wiring rules of the Institution of Electrical Engineers are given instead of the new "Regulations for the Electrical Equipment of Buildings." Were the new regulations a simple revision of the old wiring rules this fault might have been regarded as a small one, but great changes have been made throughout by the Institution in association with the various insurance companies and electric supply undertakings. This blemish in an otherwise useful pocket book is to be regretted.

Almanacs and Calendars.—We have received monthly tear-off calendars from Messrs. John I. Thornycroft and Co., Limited, of Southampton, together with a pocket wallet; Messrs. Mawdsleys, Limited, of Dursley, Gloucestershire; Messrs. C. A. Parsons and Co., Limited, of Heaton Works, Newcastle-on-Tyne; Messrs. Stewarts and Lloyds, Limited, of Winchester House, Old Broad-street, London, E.C. 2; Messrs. A. West and Partners, 36, Broadway, Westminster; Messrs. Geo. Cradock and Co., Limited, wire-rope manufacturers, of Wakefield; Messrs. Joseph Westwood and Co., Limited, bridge builders, constructional engineers and grab makers, of Millwall; Messrs. Ruston and Hornsby, engineers, of Sheaf Iron Works, Lincoln; Messrs. C. Isler and Co., Limited, artesian well engineers of Bear Lane, Southwark-street, London, S.E.1; Messrs. H. B. Skinner and Co., Limited, printers, 124–126, Denmark Hill, London, S.E.5; Messrs. Peckett and Sons, Limited, locomotive builders, Bristol; The Davenport Engineering Company, Limited, of Bradford; Messrs. Le Grand Sutcliff and Gell, Limited, artesian well and boring engineers, Southall, London, W.; The Ironite Company, Limited, flooring and waterproofing specialists, of 11, Old Queen-street, Westminster, London, S.W.; Messrs. Charles Pearson and Sons, Limited, manufacturing stationers and printers, 53 and 55, Mansell-street, Aldgate, London, E.1; and daily tear-off calendars from the Hoffman Manufacturing Company, Limited, of Chelmsford, Essex, Messrs. Harrison and Sons, Limited, of 44–47, St. Martin's-lane, London, W.C. 2. The English Electric Company, Limited, of Kingsway, London, W.C.2; and The Davenport Engineering Company, Limited, of Bradford.

LETTERS TO THE EDITOR.

BOILER TESTS.

TO THE EDITOR OF ENGINEERING.

SIR,—Many readers of your paper, like the writer, must be wondering what conclusions Mr. Fedden desires us to draw from his letter in your current issue of January 2. Does he claim that the average efficiency of his boiler plant for twelve months, including all banking losses, will equal the weekly test figure of 84·8 per cent. ? Such a figure is by no means exceptional under *test conditions* even with mechanical stokers other than "Bennis," and is accepted by powdered fuel experts.

The advocates of powdered fuel firing do not depend upon such comparisons, although they can supply evidence quite as independent as Mr. Feddon's of much higher efficiency.

So far as thermal efficiency is concerned, the question can be confined to combustion when comparing the two systems, and the Sheffield heat balance does not suggest that the furnace efficiency is in any way above the average for stoker-fired units, or that it approaches what is possible with powdered fuel. On the other hand, it does indicate that the good overall efficiency was chiefly due to the performance of the superheater and economiser. If Mr. Fedden is satisfied with a boiler and furnace efficiency of 69 per cent. and an average CO_2 of 10·8 per cent., then powdered fuel can be of no interest to him, especially as he does not mention the many other advantages of the latter system, such as high efficiency with small, low-grade fuel, elimination of banking losses, reduced maintenance charges, &c.

Other British power-station engineers have investigated the two systems exhaustively, and Mr. Feddon may soon receive evidence which will satisfy him on the point which he has raised.

"B.TH.U."

The Engineers' Club, Coventry-street, W. 1.
January 6, 1925.

THE WHITWORTH SCHOLARSHIPS.

TO THE EDITOR OF ENGINEERING.

SIR,—Mr. Macdonald, in the last paragraph of his letter appearing in your issue of December 12, points out the reason why such a large percentage of Whitworth Scholarships go to Dockyard Apprentices. To this is added the fact that in general engineering works there is a distinct and unmistakable tendency to look upon academic qualifications with some measure of contempt, as is evidenced by the last letter in the current issue of ENGINEERING over the signature "Not a B.Sc." The expression of opinions such as this discourages the would-be apprentice scholar because he is forced to the conclusion that his technical successes are likely to operate against him.

The typical attitude of "Not a B.Sc." drives many of our best brains into the teaching and allied professions and results in the state of affairs so clearly stated by M.I.Mech.E. in your issue of December 5. I have met it in many quarters and the atmosphere created is certainly not such as to induce apprentices to study. The student is looked upon with distrust by his foreman or manager (possibly because he may one day be a rival) obstacles are put in his way, he is scoffed at, and he is given no opportunity of co-relating his studies with his practice. I think you will agree that so long as these conditions exist, the Whitworth Scholarships will continue to go to the Dockyards.

"Not a B.Sc." evidently does not know the true position of university training in the scheme of things. The training is intended to be the foundation of the practical work and certainly not the varnish. I should imagine that when he meets a graduate he expects him to be a perfect engineer, infallible, and with a comprehensive knowledge of the latest practice all the world over. I should like to ask "Did he give the graduates a fair chance ?"

If a man have a higher technical value than one who has passed an examination is it possible for him to have acquired his value without study ? Not unless he is a copyist. Sir Frederick Bramwell would have mixed feelings could he read the second paragraph of the letter. I can assure "Not a B.Sc." that it is possible to study and to produce results at the same time. Many external graduates of London have worked in the shops while pursuing their studies and when he writes as he does in your last issue, he does such men a grave injustice.

I know one first class honours graduate of London who commenced work at the age of fourteen, studied in evening classes at a provincial technical college, where the curriculum in those days was not of university standard, and during this time he kept the wolf from the door. He had very few books, could not afford correspondence courses, and he had to shoulder the responsibility of chief breadwinner, together with a considerable debt. During his studies he worked overtime in the shops, earned recognition, and was promoted to the drawing office, latterly taking the position of responsible head. He had to travel the country, take dimensions and the attendant responsibility, but he persevered and attained a first class. The examination lasted for 42 hours.

Does "Not a B.Sc." realise the serious injustice he does to such graduates when he generalises as shown by his letter, and does he consider that such a result could be attained, under the circumstances outlined without "grit" ? I know he includes the saving clause "if they are one's only qualifications" but the general tendency of his letter is to belittle the graduate wherever he may be. You, Sir, know as well as anyone the value *in practical work*, of a sound extensive training in the principles of engineering, particularly in the higher branches of the art, and it is significant that the Institutions of Mechanical and Civil Engineers recognise the degree as a qualifying examination.

"Not a B.Sc." says he would be seriously handicapped if he exchanged his experience for the highest academic distinction in the world. It depends in what walk of life he was placed with his despised distinction. I would assure him, that had he digested the curriculum of either the B.Sc. degree, or the Whitworth Scholarships, he would not be handicapped, but on the other hand he would be able to solve problems rationally in his practical work, for he cannot deny that, however practical he is, he is sometimes confronted with difficulties which he overcomes by the "cut and try" or the "jump in the dark" method.

In conclusion I would like to ask "Not a B.Sc.," presuming he did have some kind of technical training, whether he condescended to receive it at the hands of a graduate, or whether he had it from the practical man, the man who generally does what he has seen others do without reasoning why ? I should also like to ask him what percentage of the books in his library are written by the useless (?) graduate, and when he chooses a book from a list what influences him in his choice ?

Yours truly,
H. H. W.

Wigan. December 22, 1924.

TO THE EDITOR OF ENGINEERING.

SIR,—The Universities of Akron and Cincinnati, and the Antioch College of Dayton, Ohio, have all adopted, or rather adapted, educational methods similar to that which has proven so successful in the Royal Establishments.

Possibly it would pay anyone who is interested in technical education in England to investigate the results obtained by these methods in the above-mentioned technical colleges.

Yours very truly,
S. M. UDALE, B.Sc., LL.B., A.M.Inst.C.E.
Holley Carburetor Company, Detroit, Michigan.
December 16, 1924.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with some interest the various letters which have appeared in your columns during the past few weeks, on the subject of "Whitworth Scholarships," and I should like to comment on the points raised by your correspondent, "Not a B.Sc.," in your issue of the 19th inst.

While agreeing with him that a man holding a Whitworth Scholarship or a University Degree is not necessarily a better man than a man without these qualifications, I would point out that the leading engineers of to-day, as represented by the various engineering institutions, recognise the University degree, combined with suitable practical training as the very best preliminary equipment for the young engineer.

Further, the works manager who engages an assistant on the faith of academic qualifications alone is asking for trouble, when one considers that a University degree can be obtained at the age of 19 years.

Your correspondent also states that nearly all University graduates lack originality. Surely, this is a trait peculiar to the individual rather than to any particular section of the profession, and evidently "Not a B.Sc." has not been in close touch with the research work carried out in applied science by the University graduate.

I should like particularly to question your correspondent's statement that a man cannot study to pass examinations and also labour to produce results useful to his fellow-men. When one considers, as I mentioned previously, that a degree may be obtained at the age of 19 years, there is still ample time in which to produce results useful to one's fellow-men, and the equipment for such labours is surely much finer than if no time had been spent in study.

In conclusion I should like to say that the tendency seems to be for the practical engineer to expect a young University graduate to have the experience of an older man, in addition to his training.

Let us as engineers give credit to the pure scientists, to whom we owe so much for our knowledge of the great forces of Nature.

Yours, &c.,
INTERESTED.

London, December 27, 1924.

TO THE EDITOR OF ENGINEERING.

SIR,—Forty years ago, during the last year of my apprenticeship in a marine engine works in the north, I attempted to gain a Whitworth Scholarship. In those days, I remember, the standard required was to pass first class in six advanced engineering subjects in *one* session. My hours of work in the fitting and erecting shops were from 6 a.m. to 5 p.m., normally 54 hours per week, but rarely a week passed without overtime, sometimes one and even two all-nights per week, with weekly hours ranging to 80 and 100 hours. The extraordinary difficulties, under such circumstances, of carrying on evening classes, and the necessary home studies, for six different subjects, in the advanced sections, are not easy to explain. The effort was almost *superhuman*, from September to May, with not a single hour's relaxation from Monday morning to Saturday night. However, I succeeded in getting round to the actual week of the examinations, took the first three (and passed successfully), and was the rest of that all-important week in bed with throat trouble, and so was disqualified. I had no redress, and my one opportunity was gone for ever. Are student engineers not better placed to-day ? I hope so.

Yours truly,
A. VENNELL COSTER, F.R.G.S.,
Expert Engineer, Bryant and May.
Fairfield Works, Bow, London, E. 3.,
January 6, 1925.

SOUTH AFRICAN INDUSTRY.—The annual report for 1924 of the British Manufacturers' Representatives Association of South Africa states that the number of factories in the Union has increased from 4,000 to over 7,000 in the past five years, while industries numbered well over 100. In the year 1915-16 the output of the factories in the Union was valued at about 40 millions sterling. By 1921 it had increased to over 98 millions sterling, though the following years showed a considerable decrease. The Association report expresses regret that the Imperial Conference proposals were not adopted by the late home Government. The association is very active in many directions, and is doing a considerable amount of work which should foster South African industries and at the same time improve trade within the Empire.

SHEFFIELD TRADE.—The industrial supplement to *The Sheffield Daily Telegraph*, published at the close of last year contains a number of interesting articles on the present situation of various branches of the engineering industry. Mr. W. L. Hichens suggests a number of ways in which Government might assist in bringing about a revival of trade. Mr. H. G. Williams deals with the future of the machine tool trade, pointing out that the British machine tool maker can hold his own under fair conditions with other countries, and can satisfactorily supply tools to cope with any class of work. Sir W. P. Rylands contributes an article on Britain and the world's trade, while steel houses are discussed by Sir Charles T. Ruthen. The Right Hon. John Hodge, P.C., reviews labour conditions of the past year, and various leaders give their opinions of the prospect of business in the year now opening. It must be admitted, we think, that the British manufacturer has succeeded in meeting with a very cheerful face conditions which for long have been extremely trying, and we trust that the hope running through this review and forecast will materialise into substantial progress in the ensuing months.

SHEFFIELD INDEPENDENT TRADE REVIEW.—The annual *Sheffield Independent* Trade Review contains a summary of the trade of the Sheffield district, which for 1924 proved to be rather irregular in character. It is satisfactory to note, however, that in the opinion of many prominent business men it has shown distinct signs of improvement, and that the outlook, by the majority of those whose opinions are given, is stated to be more hopeful than for some while back. The review deals in a very informative manner with the local affairs of Sheffield, both municipal, industrial, and commercial. The material is gleaned from a variety of authoritative quarters, and a good idea is conveyed of the activities of different branches of the industries, reference being made to specially interesting contracts or of changes introduced. There are articles on the cutlery trade, steel industry, engineering, and mining, colliery developments, and so on. Under light and power are discussed the advantages of electricity for all purposes, and of gas for heating. The conservation of our coal supplies also receives attention. An article on "Round the District" brings together a number of subjects, and forms an interesting review of recent and prospective work, on the whole with favourable indications.

THE PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.

THE fifteenth annual Exhibition of electrical, optical, and other physical apparatus, arranged by the Physical and Optical Societies of London, one of the first important events of the scientific season, was held on the afternoons and evenings of Wednesday and yesterday, in the Imperial College of Science, South Kensington. The main arrangements were as usual in the hands of the senior Secretary of the Physical Society, Professor A. O. Rankine, of the College. A few firms which have hardly missed any previous exhibition have dropped out this year, but others came in, and the number of exhibitors was 55 against 53 in the two last years. Two discourses were given on each of the two days on which the Exhibition was open, the one by Mr. F. Twyman, F.R.S., on "Some Experiments with Interferometers," in which reference was made also to the use of the interferometer for calibrating standards of length by the apparatus of Messrs. Hilger, described in our issue of October 3 last, and by Mr. C. F. Elwell, on "Talking Motion Pictures."

The Cambridge Instrument Company, Limited, demonstrated the use of several novel mechanical and other instruments. The airship strainmeter, developed by the firm in co-operation with Mr. E. B. Moullin and Professor C. F. Jenkin, is an extensometer for measuring changes in the length of a wire or girder under load by the method used in the Moullin torsionmeter which we illustrated in our issue of June 13 last. Two twin electromagnets with laminated cores are mounted on a frame in such a way that one half of each electromagnet is rigidly connected to the frame, the other to the wire. The instrument itself is quite small. Normally the two pairs of pole faces are in contact, and they are kept in contact by a metal diaphragm. As the wire is stretched an increasing pole gap develops. When an alternating current, constant as to volts and frequency, is applied to the electromagnets, the reactance of the windings on the magnet cores will vary with the length of the pole gap, and the instrument is so designed that the current variations are directly proportional to the extension of the wire. This current is measured on a Duddell thermo-ammeter, in series with the windings, and calibrated to read directly to 0·01 mm. of gap. For the demonstration a 2-mm. wire, 60 cm. long, was used and loaded by means of a weight suspended from it by a spiral spring. An instantaneous record of the load at any moment was obtained by the aid of a new Duddell oscillograph, in series with the ammeter. One of the remarkable photographic records obtained, owing to the vibration of the spring which had a half-second period, is reproduced in Fig. 1, on which 6 mm. correspond to a load of 1 ton per square inch.

With this improved Duddell oscillograph simultaneous records are obtainable from three vibrators (electromagnetic or electrostatic combinations), with the aid of one camera and one four-volt metal filament lamp, the whole unit—vibrator, and magnet system—taking up not more than 8 cm. in width. In order to secure an intense illumination the lamp is overrun for the fraction of a second of the exposure; the mechanical shutter opens the camera 0·05 second after the excess volts have been supplied to the lamp. The records are obtained on a film or bromide paper on a revolving drum; the whole length of the film (48 cm.) may be used for one or for three or four exposures, by setting the shutter. Up to the moment of exposure

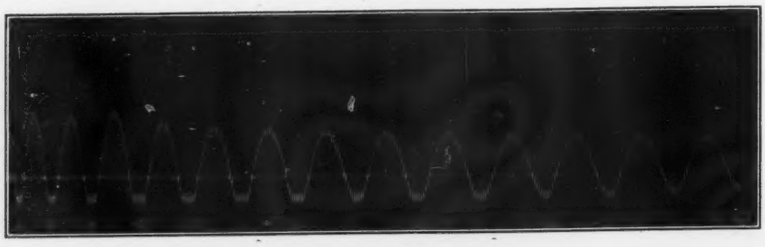


FIG. 1. AIRSHIP STRAINMETER RECORD.

Fig. 2.

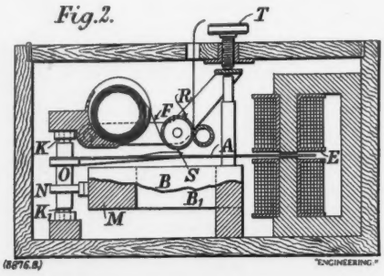


FIG. 3. 8-H.P. ROVER CAR, SPEED 28 MILES PER HOUR.

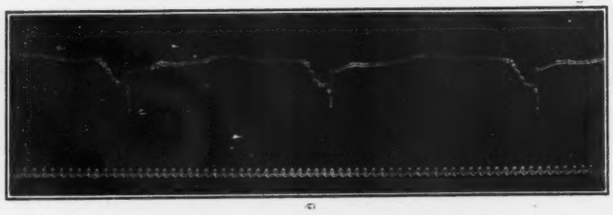


FIG. 4. SHAPING MACHINE WITH 15-INCH STROKE AND QUICK-RETURN MOTION. TIME MARKING, ONE-TENTH SECOND.

FIG. 5. SHAPING MACHINE WITH 10-INCH STROKE AND QUICK-RETURN MOTION. TIME MARKING, ONE-TENTH SECOND.

FIGS. 3 TO 9. ACCELERATION DIAGRAMS TAKEN ON CAMBRIDGE RECORDING ACCELEROMETER.

FIG. 6. NORMAL MAN; VERTICAL ACCELERATION.

FIG. 7. NORMAL MAN; HORIZONTAL ACCELERATION.

FIG. 8. MAN WITH ARTIFICIAL LEG; VERTICAL ACCELERATION.

FIG. 9. MAN WITH ARTIFICIAL LEG; HORIZONTAL ACCELERATION.

a stationary image of the wave form can be obtained.

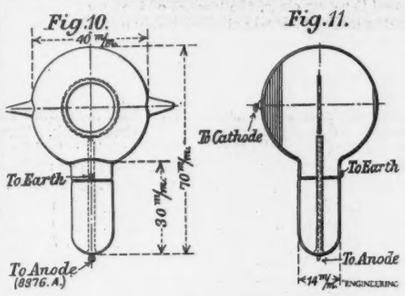
The recording accelerometer of the Cambridge Instrument Company measures accelerations on motor vehicles, lifts, aeroplanes, &c., and provides a means of studying the springing of vehicles and the "comfort" to be obtained with different kinds of tyres. The records are produced by scratching on celluloid, as in the vibrograph of Mr. Collins, which we noticed last year and which was again exhibited. Fig. 2 is a plan of the accelerometer when placed for taking records of vertical accelerations; the instrument box, 10 by 8 by 4 in., can be held either side up. The mass M, supported by flat steel springs B B_1, is connected by another steel strip N to a spindle O moving on knife-edges K, K_1; O carries the aluminium strip A, to which the stylus S is fixed. As M moves, the stylus passes across the celluloid film F, which clockwork draws round the roller R at a rate adjustable between 3 and 20 mm. per second. The electromagnet E, between the poles of which A is swinging, serves as a damper for the oscillations of A. The screw T admits of varying the pressure of the stylus on the film. The curves reproduced in Figs. 3 to 9, exemplify records taken by this accelerometer when carried on a motor-car travelling at 28 m.p.h., on a shaping machine, and by two pedestrians, the one normal, the other provided with an artificial leg.

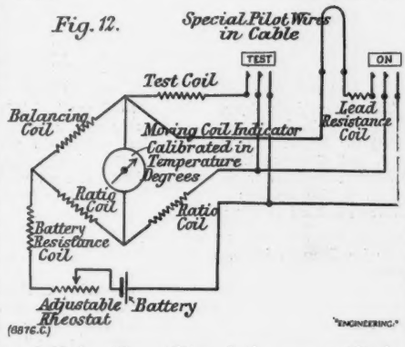
Photometry by means of photo-electric cells, the current through which is proportional to the intensity of the incident light, offers advantages over the method of visual comparison. In these cells a metal (usually alkali), is deposited on part of the inner, silvered wall of a glass bulb; the light falling on this film, through a window (not covered by silver), ejects electrons from the metal which, striking a ring-shaped anode, generate a current proportional to the light intensity. The current may be amplified by applying an accelerating potential, which ionises the rare gas in the cell, which is usually helium, by collision; thus currents of the order of 10^{-9} ampere for 1 metre-candle are produced. When the metal is potassium the curve resembles that of a photographic plate; with cæsium it approximates the sensitivity curve of the eye. In the photo-electric cell of the Cambridge Instrument Co., illustrated in Figs. 10 and 11, the metal is potassium, colloidally deposited in Professor F. A. Lindemann's (Clarendon) laboratory at Oxford. The Lindemann electrometer (which was illustrated on page 20 of our issue of January 4, 1924), through which, in series to a high resistance, the instrument is earthed, is used for measuring the photo-electric potential. For strong lights an ordinary galvanometer may be used.

The thermionic voltmeter, a patent of Mr. E. B. Moullin, another exhibit of the company, measures small potential differences at any frequency without absorbing any power from the circuit under test, the action depending on the rectifying power of a triode valve. The instrument is made in two patterns. Pattern A employs the curvature of the anode current/grid-potential characteristic and needs no special anode battery, the only variable factor being the filament battery of 6 volts; this battery, the valve, and a sensitive unipivot voltmeter are mounted in one box. Pattern B can be used also for measuring alternating-current potentials superposed on steady direct-current potentials. The standard range of B is 0 to 5 volts, readings being obtainable to 0·5 volt; pattern A reads to 0·02 volt. The thermionic voltmeter is also applicable for measurements of power factors, inductances, &c.

The new six-dial low-induction resistance box of the Cambridge Instrument Co., suitable for frequencies up to 2,000, is due to Mr. A. Campbell, late of the National Physical Laboratory, and contains all the parts in one box. The company has also taken up the manufacture of the portable frequency meter, another beautiful instrument of Mr. Campbell, which was described before the Physical Society on December 12 last, when the simplicity and sensitiveness of the working was strikingly demonstrated, as it was again at the Exhibition. The action of the instrument, which is particularly valuable for telephone measurements and radio-frequencies ranging from 200 to 4,000 periods, depends upon the interaction of two mutual inductances, balance being indicated by silence in the telephone.

Among further exhibits of the Cambridge Instrument Company were fixed and variable air condensers, which embody modifications due to Mr. W. H. Lawes, and eliminate errors due to the flowing and temperature variations of semi-plastic materials such as ebonite, by making the insulators of glass balls, definitely located between the plates by the Kelvin hole, slot and plane device. There are six glass balls at the top and the bottom of the three supports. The three on the top of the three supports are fixed in the ordinary way between parallel planes. The three lower balls are arranged on the Kelvin plan. The mounting enables the condenser to bear considerable stress. The Zamboni disc standard batteries of Major C. E. S. Philips, which were described in our comments upon the Royal Society Soirée, June 20, 1924, page 801, are now made for p.d. of 500 volts with discs of 130 mm. diameter, and in smaller rod form (15 mm. diameter) for electro-





scope work. The utility of the new outfit for recording hydrogen-ion concentration will be appreciated in laboratories, tanneries and breweries, and by agricultural chemists who watch this concentration in the soil; it can also serve for determining the acidity of boiler-feed water. The hydrogen-ion concentration is determined with the aid of gold electrodes in a quinhydrone solution; the glass cells are of the H-type and the outfit requires a thread recorder.

Messrs. Siemens Brothers and Co., Limited, demonstrated how, by the aid of their cable temperature indicator, a continuous watch can be kept on the temperature of a buried cable, thus dispensing with the need of determining the loading limit of a cable by means of calculation, based on assumptions concerning the thermal resistivity of the soil and the influence of the load of one cable on the temperature of another. The action of the indicator depends upon the change with temperature in the resistance of special pilot wires of nickel imbedded in the cable and joined to a Wheatstone bridge, the indicator of which is a moving coil calibrated in deg. F. The connections will be understood from the diagram, Fig. 12. The wires are inserted as a pair of small pilot cores connected in series so as to form a loop; in extra high-tension feeders they are introduced near the lead sheath where they do not require such high insulation as would be necessary in the cable centre. The pilot wires, it will be understood, must be embedded while the cable is being made. The indicator, which is connected to the pilot wires by ordinary twin copper cable, sometimes of considerable length, looks like a voltmeter. The panel used in the demonstration was further fitted with arrester, rheostat, controlling switch, &c., so that the cable length could be put under current and the rise of temperature watched. The 4-colour temperature recorder which we noticed on January 11, 1924, was shown, and also a simpler drum recorder form of this device. The thermo-electric potentiometer, &c., of the firm was illustrated in our issue of April 13, 1923; an optical pyrometer was also exhibited measuring up to 2,400 deg. C., and a 40-way distance thermometer switchboard which indicates temperatures within the range − 200 to + 500 deg. C., and is intended for use in cold stores, ships, chemical works, &c.

The Frost patent emergency wireless signal apparatus, of Messrs. Evershed and Vignoles Limited, mentioned last year as shown in the model stage, has since been put on the market. It is due to Captain S. G. Frost and the firm. The whole set, housed in a strong teak box, contains the Evershed wireless generator, and the Frost transmitting drum coupled to a spark or a valve transmitter. The generator is of the Megger type and is preferable for such work to batteries. Contacts for Morse signals likely to be wanted for repeated transmission in emergency cases, *e.g.*, S.O.S., the ship's name, and the lifeboat number, are grouped on the outside of a cylindrical drum which fits into the box; when the generator handle is turned, these signals are automatically transmitted. The apparatus is supplied in two types, the one for valve transmission on aeroplanes, the other for spark transmission on ships' lifeboats. In the former case the generator is a double-wound d.c. machine, supplying low-tension currents to the valve filament and high-tension currents to the anode; the transmitting drum is included in the grid circuit. In the latter type, the generator supplies low-tension alternating current, which is transmitted as a Morse call by the drum, and stepped up by means of a transformer for the aerial circuit. There is, further, a lamp switch for lighting a mast head signal lamp from the generator circuit. This switch has three positions, radio, lamp, radio and lamp. In both cases the box occupies less than 2 cub. ft. of space; the transmitting range is about 60 miles. The Megger bridge testing sets and Meg insulation tester of the firm need only be mentioned. The Evershed 1,000-volt wireless generator also on view, is designed for amateur transmitting stations, and has proved successful in trans-atlantic transmission of Morse signals, and speech transmission from a lorry travelling at high speed.

The Dionic water tester of Messrs. Evershed and Vignoles has been on the market for ten years or so, but the recording form of the instrument is a novelty, involving several improvements. The idea is that the electrolytic conductivity of water depends essentially upon the inorganic electrolytes present, and that the determination of this conductivity, which is exceedingly sensitive to slight impurities, at once betrays contamination of the water, and, for example, will indicate a leakage of feed water into the condensate in a condenser. In the apparatus the liquid flows continuously through two glass vessels mounted on the same board; the one is the test vessel, the other the automatic temperature compensator. The conductivity varies with the temperature, and in the older form the compensation was obtained by the aid of a float controlled by a thermometer. The recorder has a separate case with an $\frac{1}{8}$-h.p. motor at the back of the panel. When, in the demonstration of the instrument, a little salt solution, which was coloured to be visible, was admitted into the circulation, the conductivity curve began to ascend within three seconds; on the danger-mark being reached, an alarm bell rang and a red lamp flashed up; when the contaminating salt supply was shut off again, the lamp went out and the conductivity curve returned to normal within five seconds.

Turning to some optical exhibits, we may mention the various microscopes (tank, Greenough binocular, &c.), the reflex drawing apparatus and the optical bench of Mr. C. Baker, of High Holborn. Conspicuous among the exhibits of Messrs. R. and J. Beck, of Cornhill, were a new metallurgical

microscope of radial type, in which all focusing adjustments are done on the stage, the body tube being fixed, so that the illumination, which is obtained by a new vertical illuminator, remains in position; the inverted metallurgical microscope, which is a triangular bench and provided with a photo-micrographic outfit for half-plate or quarter-plate cameras; and the ring illuminator for oil-immersion objectives with apertures up to 1·3 N.A.

The universal spectrometer and the photometer attachment to spectrometers for visible and ultra-violet light of Messrs. Bellingham and Stanley, of 71, Hornsey Rise, N.19, were illustrated on page 140 of our issue of February 1, last year. The firm also shows quartz spectrographs and examples of the "O" Taylor-Hobson F/2 lens which is designed for night photography from aeroplanes, and is also in regular use for press photography. Messrs. Bellingham and Stanley have since 1914 made a speciality of saccharimeters, and their water-jacketed polarimeter tubes are assembled without any cement. The optiscope of Messrs. W. Butcher and Sons, of Farringdon Avenue, is a simple, compact optical lantern fitted with gas-filled lamps, which may be connected to ordinary house circuits. The firm also exhibited their auto-print, vertical-type frame for enlarging, copying, and also photographing.

(*To be continued.*)

LABOUR NOTES.

THE shipbuilding returns for the fourth quarter of 1924, compiled by Lloyd's Register, do not support the contentions of the trade unions that the state of the industry warrants an advance of wages. The tonnage in course of construction on December 31 was down about 171,000 as compared with the position at September 30, and about 98,000 as compared with the position twelve months ago. During the three months which ended on December 31, 1924, yards in Great Britain and Ireland launched 102 vessels of 352,629 tons gross, and commenced only 79 vessels of 194,594 tons gross. On the showing of these two sets of official figures the industry is, therefore, making serious leeway, and the fact is bound, we suggest, to have an important bearing on the wages negotiations that are about to begin. In Denmark, France, Germany, Holland and Italy, a larger amount of tonnage was commenced than was launched.

Mr. A. B. Swales, chairman of the General Council of the Trades Union Congress, and a member of the executive council of the Amalgamated Engineering Union, has returned from the United States after attending the annual convention of the American Federation of Labour. Of the conditions that obtain on the other side of the Atlantic he says, in the course of an article in the "Labour Press Service," that "mass production, gigantic combinations of employers—trusts—and the ruthless oppression of large numbers of unorganised and ill-organised workers, are features that strike the inquiring trade unionist from England." "Nevertheless," he goes on to remark, "I did notice that the American worker, in the main, is able to live properly and decently on what he receives in wages, in contrast to the dull drudgery and semi-starvation of most of the workers in England." No doubt, Mr. Swales will, in a subsequent article, give the results of his investigation of the reasons why American industry finds it profitable to pay these high wages. One of them is assumed to be the Transatlantic worker's better output—which is not restricted, officially and unofficially, as it is here. In the United States the output of work per head is, if our memory serves, higher than it is in any other country.

There appears to be a widespread controversy of exceptional keenness in the United States on the subject of the twentieth, commonly called the children's, amendment to the Constitution. Since the amendment was passed by Congress one State Legislature has ratified and three have rejected it. The others are to vote upon it within the next six months and great efforts are being made to sway them one way or the other. The text of the amendment is as follows:

"Section 1.—The Congress shall have power to limit, regulate, and prohibit the labour of persons under 18 years of age."

"Section 2.—The power of the several States is unimpaired by this article except that the operation of State laws shall be suspended to the extent necessary to give effect to legislation enacted by the Congress."

The amendment is thus only an "enabling Act," which gives to Congress power already possessed by the States. If it is ratified, Congress will be able to pass laws to "limit, regulate, and prohibit the labour of persons under 18 years of age" when, in its judgment, those persons need protection.

It has been generally believed that Congress had the power to protect children in this way. The two Federal laws bearing on the matter were, however, declared unconstitutional. The first, enacted on September 1, 1916 "prohibited the shipment in inter-State and foreign commerce of goods produced in mines and quarries in which children under 16 years of age were employed, and in mills, canneries, workshops, factories, or manufacturing establishments in which children under 14 years of age were employed, and in which children between 14 and 16 years of age worked more than eight hours a day or six days a week or between 7 p.m. and 6 a.m." The Supreme Court declared that law unconstitutional after it had been in effect nine months. A second law—the Federal Child Labour Tax Act—was passed in February, 1919. It laid a special tax on the profits of mines and manufacturing establishments which employed children in violation of the standards of the 1916 law. It was declared unconstitutional in May, 1922. Since these two laws have been declared unconstitutional it seems clear, the leaders of the new movement contend, that Federal action can only be taken through an amendment to the Constitution.

Our Ministry of Labour some time ago attempted to compare the real wages paid in various important cities on the basis of the amount of food that could be bought from the earnings of a 48-hour week. The comparison covered only a few trades, viz.: building metal, woodworking, and printing. London was taken as the base or 100 per cent. The result was as follows:

London	100
Amsterdam	100
Brussels	57
Christiania	94
Madrid	66
New York	219
Ottawa	183
Paris	86
Prague	77
Stockholm	88
Warsaw	91

The New York figures related to August, 1923. Figures obtained subsequently (January and February, 1924) for Berlin and Vienna worked out at 48 per cent. and 47 per cent. respectively. On this showing, American workers were at that time twice as well off as British workers and, British workers in turn, twice as well off as German and Austrian workers.

In its January issue, *The Plebs*, the organ of the National Council of Labour Colleges, invites readers to send in details of modern labour-saving devices introduced in their shops. "If these are accompanied," it is added, "by actual figures relating to workers displaced, they will be the more valuable."

The Ministry of Labour states that the number of unemployed persons on the register of Employment Exchanges in Great Britain on December 29, 1924, was 1,272,600—969,500 men, 35,000 boys, 238,500 women, and 29,600 girls. On December 22, 1924, the number was 1,169,227—897,461 men, 30,281 boys, 215,850 women, and 25,635 girls; and on December 31, 1923, it was 1,285,623—946,521 men, 36,659 boys, 267,373 women and 35,070 girls. It is added that the unemployment figure, immediately succeeding Christmas, normally shows a substantial increase. The increase in this instance is about the same in amount as that of last year, and somewhat less than that of 1922.

A special congress of the International Metalworkers' Federation is to be held early in March, for the purpose of considering how the action of the German metal-workers on the question of working hours may be most effectively supported. It is stated that at present over 60 per cent. of the German metal workers are working more than 48 hours per week—in a number of cases without extra payment—and the executive of the International fears the effect on other countries if this state of matters is permitted to continue.

The question of allowing the Russian metal workers to affiliate to the International Metalworkers' Federation is in practically the position in which it was left by the Vienna Congress. If the Russian organisation accepts the constitution of the International and agrees to abide by it, its affiliation would be a pure formality. Its representatives who were at Vienna, however, showed no disposition to do so. Amongst the countries which are definitely opposed to affiliation by the Russians are, understood to be, France, Belgium and Czecho-Slovakia.

The formation of Factory Groups is one of the ways in which Communism hopes to permeate British Trade Unionism. Exactly what relation the Factory Group bears to local organisations of the National Minority Movement is not very clear, but as both have much the same object, viz, the destruction of British Trade Unionism, the point is immaterial. In the *Workers Weekly* interesting instructions are given as to how Groups should go about their business. One of the things they are advised to do is to start a factory paper. "Nothing," it is declared, "can so develop a spirit of class solidarity amongst the workers in a factory, and make them understand that the Communist Party is their only real leader, as a factory paper. It should not contain long theoretical articles or general declarations about capitalism. . . . The real body of the paper must be made up of lively comments on affairs and conditions in the factory itself or in the surrounding district." One or two factory papers, it is pointed out, are produced by the Young Communists' League, and are circulated from hand to hand.

Factory Groups are also invited to take up correspondence—first to the *Workers' Weekly* and then with a Factory Group in Soviet Russia. "The exchange of letters with a Factory Group in Soviet Russia is best carried out," it is stated, "through the party machinery and not by post. Not only will letters from a Russian Group add interest to the factory paper, but the picture of how the workers live under a Workers' Government will have an immense propaganda value." When a sufficient number of letters have accumulated, a study group is to be formed from amongst the non-party workers, under the guidance of party members, for a study on such lines as "The Workers under Capitalism and under Socialism," or "The Difference between a Labour Party Government and a Soviet Government."

Edmonton Urban District Council have been officially informed by the Government Department concerned that it is not permissible to exclude men who are not trade unionists from employment on State-assisted works. The Council, which recently decided that all their employees must be members of a trade union, have begun, with the assistance of the Unemployed Grants Committee, an extension scheme at their sewage works, involving an expenditure of 140,000*l*. In formally declining to agree with the stipulation that only trade union members shall be employed, the Minister says that he "feels there is no justification for excluding any suitable man from employment on State-assisted works merely because he is not a member of a trade union."

Until the Russian Delegation's fuller report of its investigations is available, British Trade Unionism as distinct from British Socialism, and in crises like this it is distinct enough, can hardly be said to know where it stands. Mr. Purcell and his associates were a Trades Union Congress, not a Labour Party, delegation, and to the General Council of the Trades Union Congress they will have to report on, presumably, the matters relating more particularly to labour conditions and wages. It will serve no useful purpose, however, to deny that their political views, as expressed in their preliminary report, and also in their Russian speeches, interviews, and messages—which are, admittedly, a totally different story—have had the reverse of a unifying effect on the rank and file in this country. Except in Communist circles, Russian methods are seriously distrusted here. Elsewhere they are, judging from the reports of the meeting in Brussels last week-end of the International Socialist Bureau, in as little favour. M. Jouhaux assured M. Vandervelde that he need have no fear regarding the attitude of the Amsterdam International on the main question raised by the British delegation's preliminary report. They would want to know where the British delegation stood, and would have nothing to do with the so-called united front.

THE BRITISH JOURNAL PHOTOGRAPHIC ALMANAC.—Many editions of the British Journal Almanac have been published which have thoroughly established the position of this annual with those who use photography as a business or as an accessory in works and offices. The edition for 1925 more than maintains the reputation of its predecessors, with its accumulation of tables, notes on new apparatus, and particularly with its article by the editor on "The Plain Facts of Lenses." These plain facts, embracing, as they do, descriptions of the different forms of lenses, their properties and uses, with helpful notes on exposures when employing them, are in a clear and masterly style, and will be found of service to all users of the various types of an instrument in the design of which important progress is being constantly made. The almanac is published by Messrs. Henry Greenwood and Co., Limited, 24, Wellington-street, London, W.C.2, at the price of 2*s.* in a paper cover, and 3*s.* cloth bound.

CARBON-MONOXIDE INDICATING APPARATUS.

MOST of our readers are probably familiar with the method of measuring by electrical means the proportion of carbon dioxide in flue and other mixed gases, apparatus for this purpose having been supplied by the Cambridge Instrument Company, Limited, 45, Grosvenor-place, S.W.1, for some years. We may mention, however, before describing similar apparatus recently introduced for the measurement of carbon monoxide, that the Wheatstone bridge principle is employed, two arms of the bridge consisting of electrically-heated platinum spirals of which one is exposed to the flue gas and the other to pure moist air. The heat dissipated from the wires forming the spirals is dependent upon the density of the gases in which they are located, so that the temperature, and, consequently, the resistance, varies with the amount of carbon dioxide present, the proportion being indicated by the out-of-balance current flowing through the galvanometer. The latter is graduated so as to give a direct reading of the percentage of carbon dioxide.

FIG. 1.

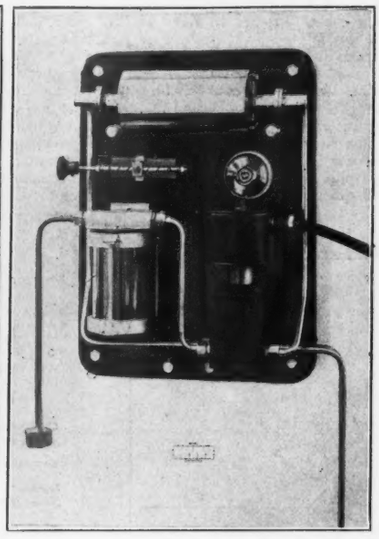


FIG. 2.

The carbon-monoxide indicating apparatus, with which we are now concerned, is generally used in conjunction with a carbon-dioxide indicator, since a knowledge of the proportions of both gases is necessary in order to determine that complete combustion of the fuel has been effected. A single indicator of the type illustrated in Fig. 1, above, is arranged to give readings of either carbon dioxide or carbon monoxide, and since the gas is passed through the two measuring instruments in series, only one soot filter and one aspirator are required for the combined installation. Fig. 2 shows the carbon-monoxide measuring apparatus arranged on a panel the dimensions of which are 12 in. wide by 16 in. high, and on which are mounted a glass-walled gas bubbler in which the aspirator is incorporated, a double-celled meter box, an electrically-heated furnace, a rheostat and a tumbler switch. The switch and rheostat are provided to control the supply of current from the mains to the furnace and the objects of the other components will be apparent later.

Copper-pipe connections on the panel are arranged so that the gas, which enters through the pipe on the left, is passed first through the bubbler and aspirator and then into one cell of the meter box. On leaving this cell, the gas passes upwards to the furnace, the heat of which converts any carbon monoxide present into carbon dioxide so that the proportion of the latter is increased. The gas from the furnace is led again to the meter box, passing this time through the second cell, and finally leaving through the pipe connection on the right. The two cells of the meter box, it should be mentioned, each contain a heated platinum spiral forming one arm of a Wheatstone bridge arranged as described above, and connected to the indicator by the leads shown on the right of Fig. 2. The difference in the proportions of carbon dioxide present in the cells, resulting from the conversion of carbon monoxide to carbon dioxide in the electric furnace, affects the resistance of the spirals and disturbs the balance of the bridge as already explained, so that the reading of the indicator, suitably calibrated, is a direct measure of the percentage of carbon monoxide originally present in the flue gas.

The indicators, as usually supplied, are graduated to read from 0 to 20 per cent. of carbon dioxide and from 0 to 10 per cent. of carbon monoxide, these ranges being suitable for flue-gas analysis in boiler plants, &c. A two-way switch fitted on the indicator enables the proportion of either constituent to be measured independently, and, by substituting a four-way or six-way switch, measurements of both constituents can be obtained from two or three different parts of the flue. It is also possible to obtain temperature measurements on the same instrument, as well as to obtain continuous records by employing suitable recording apparatus. The same principle, it may be mentioned in conclusion, can also be used for determining the proportion of almost any one gas in any other gas or gaseous mixture, one interesting industrial application of this being the measurement of the proportion of ammonia in a mixture of nitrogen and hydrogen in connection with the production of ammonia by synthesis.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—The Minutes of Proceedings No. 12, just published by this Institution, contains a reprint of a paper on "Braided Rubber Shock-Absorber Cord for Aircraft," by Mr. L. Rowland, read at a meeting held in March of last year, together with a report of the discussion on this paper. It also includes a report of the Sixth Annual Meeting of the Institution at which Lieut.-Col. J. T. C. Moore-Brabazon delivered his Presidential Address, and a paper on "Empire Communications" was afterwards read by Mr. A. H. Ashbolt. Copies of the Proceedings are obtainable from the Offices of the Institution at 60, Chancery-lane, W.C. 2, price 1*s.* 6*d.*

A WEATHER FORECASTER.—A beautifully made little pocket instrument for forecasting the weather has been sent to us by Messrs. Negretti and Zambra of 38, Holborn Viaduct, London. The accuracy of this instrument under all conditions we have naturally not yet had an opportunity of testing, but it certainly only too correctly forecasted that January 2 would be "very unsettled with rain." The instrument consists of three discs, one being engraved with a scale for the direction of the wind, and the second for the barometer reading. When these are set to the prevailing conditions a code letter is exposed through a window in the top disc, which, by reference to a table, indicates the probable weather conditions for the succeeding 12 hours. Different code letters are indicated for summer and winter periods.

INDIAN TRADE.—The trade returns of British India for the month of October, 1924, showed, as compared with the preceding month, decreases in the value of imports and re-exports, with an increase in exports. The imports of private merchandise totalled Rs. 20,84 lakhs in October, and showed a decrease of Rs. 1,98 lakhs, as compared with the preceding month. Metal imports during October, however, increased by Rs. 17 lakhs, compared with the September imports, while railway plant, rolling stock, and machinery, including belting, showed decreases of Rs. 50 and Rs. 40 lakhs, respectively. Exports of Indian produce and manufactures rose in value from Rs. 27,10 lakhs in September to Rs. 29,07 lakhs in October, 1924, while re-exports decreased by Rs. 54 to Rs. 76 lakhs.

CHEMICAL AND METALLURGICAL INDUSTRIES IN CANADA.

A REVIEW of Canadian industries was undertaken in 1916, with the object of aiding the development of new industries by presenting a concise account of raw materials available, their possibilities and exploitation, market requirements, &c. The report published under the title: "Development of Chemical, Metallurgical and Allied Industries in Canada in relation to the Mineral Industry," drawn up by Dr. Alfred W. G. Wilson, a volume of 329 pages [Canada: Mines Branch, No. 597], is of a type more familiar to the Colonies than to the Old Country. It might be described as a concise technological compendium, with special regard to Canadian conditions. Taking, for instance, the chapter on sulphuric acid, we find notes on the properties of the acid, on the raw materials, manufacturing processes, industrial uses, imports and exports and the Canadian situation. In a similar way other heavy chemicals, electrochemical and electrometallurgical products, gases, plasters and cements, oils, forest products, metals, foods, ceramics, paint and general manufactures are dealt with. Most of the actual figures refer to the period 1919 to 1922.

Dr. Wilson has undoubtedly spent a vast amount of conscientious work on his compilation, which seems to be reliable and free from unnecessary phrases. But the report is, of course, a record for the Canadian rather than for the general reader, though the specialist will be interested to learn, for instance, that Canada makes all the ferro-alloys except ferro-vanadium. The report informs a man who discovers a clay on his land what is done and might be done with it; and tells him where to find further information. But the scope of the book is wide, and the information cannot but be general and impersonal. We see that, though pyrites abound in Canada, whilst sulphur has to be imported, practically all the sulphuric acid is made from sulphur in nine works, which are not specified. In the case of metallic sodium we notice that the Castner and Griesheim processes are applied; but it is not mentioned that the much more important soda and bleach works use Gibbs cells, and details are rare. Canada has no nitrate of soda and possesses no works for the fixation of atmospheric oxygen. In 1918, 95·8 per cent. of the iron ores smelted in the country was imported, as was 60 per cent. of the coke required for the blast furnaces, and these percentages have been rising since. There were, in 1918, 745 iron foundries and 26 mills; machine shops are not mentioned. The half-page on cobalt is rather disappointing, though the industrial development of cobalt lies still in the future; it should largely take place in Canada.

The report contains a number of tables of trade statics covering all classes of chemical and allied products, giving imports, exports, &c. To judge by the ownership of the securities held by Canada, Great Britain, the United States and other countries, these were respectively interested at the end of 1921 in the chemical industries in the ratios 22 : 13 : 64 : 1; in the metallurgical industries the figures were 18 : 32 : 45 : 5. These average percentages vary, of course, very much with the different branches. Thus Canada owned practically all (94 per cent.) of her fertiliser works; in acids and alkalis the proportions of the capital invested by the three countries mentioned were 36 : 18 : 46; in coal tar products, 12 : 49 : 39. Again, 99 per cent. of the capital invested in silver-cobalt smelting was Canadian; for copper, lead and zinc Canada and the United States shared the capital in the proportions 51 : 49, whilst as regards nickel-copper smelters and refiners the countries participated in the ratios 8 : 43 : 45, others figuring for 7. This was because the refining of the nickel-copper matte was almost entirely carried out in Great Britain and the United States. But great developments have been taking place in these Canadian industries within the past few years, and in a little while there will be less reason to urge that British enterprise and Empire capital should assume their proper share of both the responsibility and the reward of the industrial development of Canada.

STANDARD SPECIFICATION FOR MARINE FLANGES.—The British Engineering Standards Association has issued a publication No. 3022, in which the specification for marine flanges is given. For the purpose of standardisation four working pressures, 55, 125, 225 and 325 lb. per square inch, have been adopted to cover the requirements of present-day marine practice. In drawing up the table of flanges it was found necessary to fix the dimensions of the thickness of the castings and also at the necks of valves and branch pieces, as on these and the size of bolts, the diameter of the flanges depend. Graphs are provided in this publication which give the minimum thickness of metal for cylindrical castings and maximum thickness at the neck of valves for both cast-iron and brass. The specification is obtainable from the offices of the Association, 28, Victoria-street, S.W. 1, at a price of 1*s.* net or 1*s.* 2*d.* post free.

DIE CASTING.*

By NORRIS CLEMENTS BARNARD, Worcester, Mass.

(*Concluded from page* 30.)

Dies.—Every new form of casting means a new die, and every die has its problems. Consequently, the design and construction of dies play an important part in the industry.

The sections of Fig. 8 show a three-impression die for a gearwheel. These views show the general method of constructing and of operating the die.

In Fig. 8*a* the full-line and broken-line portions represent the ejector die; the dash-and-dot line, the die base; the dash-and-double-dot line the cores and core mechanism; and the double-dash-and-dot line the ejector pins and ejecting mechanism. Referring to Fig. 8*c*, a turn of the core pinion removes the cores, while a turn of the ejector pinion ejects the casting. When the die closes after the ejection of the casting the pressure of the cover die upon the four surface pins pushes the ejector plates, and consequently the ejector pins, down into position.

In this die the casting is entirely within the ejector half. Due to the shrinkage of the casting about the three pads that form the openings in the gears, about the centre core, and about the gate post, the casting will cling to this half of the die each time the die opens. Consequently, but one ejecting mechanism is needed, while ejecting the casting is sufficient to keep the hole free from fins.

Figs. 9 and 10 illustrate two additional methods of gating and venting dies, both of which are extremely popular. In Fig. 9 the metal flows through the gate into one end of the impression, while the air passes out the other end. This makes an ideal condition in that there is one continuous, unobstructed flow of metal. A simple turning operation will remove the gate economically.

Fig. 10 shows another casting with the metal entering from the under side. In this case the metal shoots upward over the core. The location of the vents at the extreme side of the impression affords a direct flow of the metal from one end of the casting to the other. In this case a milling operation removes the gate.

When locating the gate, the vents, and even the parting line of the die, we must consider the removal of the fins formed by these various members. These operations should, naturally, be as simple as possible. In a great many instances the gate may be broken from the casting. Afterwards a file removes the remaining roughness and the venting fins. In some cases a simple machine operation, as noted above, may facilitate this cleaning. In the case of the die in Fig. 8, by pressing the gear through a shaving die that matches the periphery of the casting, all the fins are removed in one quick and simple operation. This method is screw plug. These sketches employ the same line scheme as those of Fig. 8. In this die the core mechanism operates in a horizontal plane. Only the ejecting mechanism functions from the die base. In dies of this type the ejector safety device, as shown, adds materially to the dependability of the die. Any attempt to eject before pulling the side cores places any premature effort on the safety pin rather than on the more fragile ejector pins and castings. This safeguard eliminates a great many breakdowns.

In the case of threads, the logical way to clean them is by means of a stamping die. In order to remove the castings from the die, it is necessary to part the latter along the centre line of the thread diameter, having half the thread in each half of the die. In this way there will be a portion of the thread diameter across the parting line of the die. As small portions of the venting fins and other dirt very often stick to the surfaces of the dies, and as there is a certain amount of play in the operating linkage of the casting machine, the dies very often stay open a few thousandths of an inch. This amount varies from about five-thousandths of an inch in small, simple dies to about ten-thousandths in larger and more complicated ones. Such opening of the dies causes the dimension across it to be a corresponding amount larger than a completely closed die actually measures. In most cases this tolerance is entirely satisfactory. However, if the

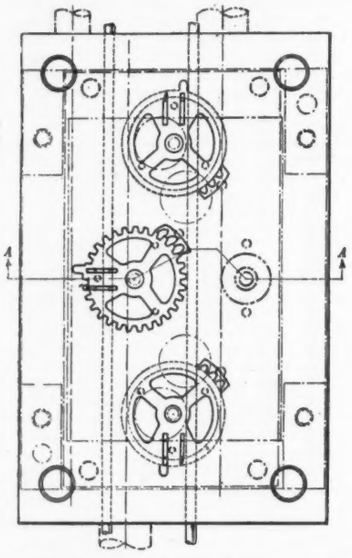


Fig. 8a. EJECTOR DIE FOR GEARWHEEL

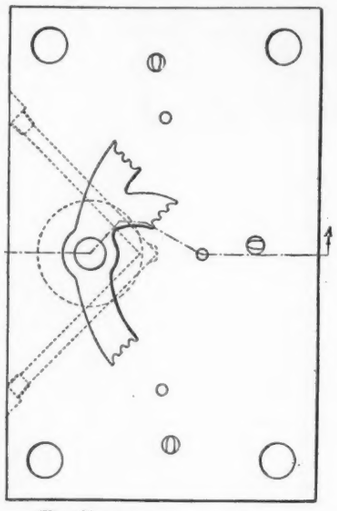


Fig. 8b. COVER DIE FOR GEARWHEEL

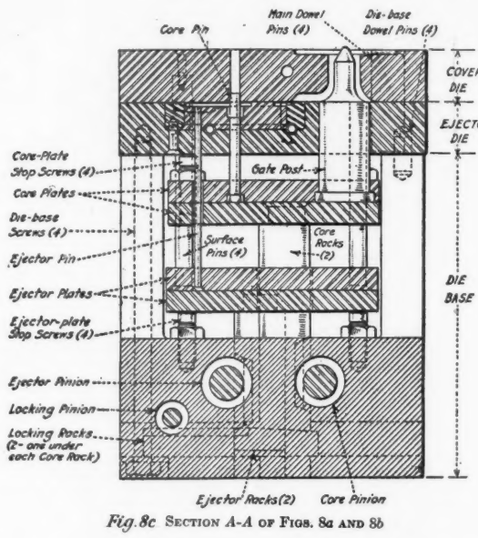


Fig. 8c SECTION *A-A* OF FIGS. 8*a* AND 8*b*

which is in this half. For this reason this die is called the "ejector die." The other half of the die merely covers it, completing the impression, so that it is called the "cover die." These halves of the die may be likened to the cope and drag of a sand mould.

The parting line between the halves of the die must contain the gate and the vents. The location of the gate should afford the metal easy access to all portions of the impression. Its position should be such that any irregularities caused by its removal from the casting will not jeopardise the appearance or usefulness of the part. In this case, the metal enters through the ends of the gear teeth.

Several methods are used to vent the castings. It is not only necessary for the air in the impression to escape but also for that in the gate and the casting chamber of the machine to pass through the vents. In some cases shims about five-thousandths of an inch in thickness are placed about the four dowel pins to form the vent. These shims hold the two dies apart, thus enabling the air to escape over the entire die surface. In other cases grooves ground in the surface of the die and extending from the impression to the edge of the die, perform the same function. These grooves are from ¼ in. to 2 in. in width, depending on the size of the casting needing venting. On white-metal dies they are about five-thousandths of an inch deep and on aluminum dies about seven or eight-thousandths.

Sometimes in a deep cavity of the die a square ejector pin placed in a round hole will suffice to vent this portion of the impression. The space around the ejector pin forms the vent. The motion of the pin

* Abstract of paper submitted to the American Society of Mechanical Engineers, 1924.

very popular where the number of castings on order warrants the construction of such a die.

In some cases it is necessary to remove the imprint of the ejector pin from the surface of the casting. It is impossible to keep the surface of an ejector pin flush with the surface of the impression at all times. The unequal expansion of various parts of the die—ejector pins, die blocks, &c.—due to the heat of the casting metal, makes these surfaces vary. These marks will always be visible on the rough casting, and in most instances they are not objectionable. However, if the pins are on a surface which will receive a high polish, they may be placed five or ten-thousandths of an inch below the surface of the die, the resulting bosses on the casting being ground off before the polishing operation. If the pins are on a surface that will fit against some other part when assembled, they may extend five or ten-thousandths of an inch above the die. The resulting depression in the castings will not affect the fit between the two parts in any way.

The constant operation of the die results in a great deal of heat within the die steel. All the excess heat of each casting passes into the die itself. This heat includes the latent heat of solidification plus the heat it is necessary for the casting to lose in order to reach a stable temperature. Water passing through holes drilled in the die block removes this heat. The location of these water channels at strategic points of the die keeps all parts of the steel at as nearly the same temperature as possible.

If this cooling functions properly, the rate of production depends very largely on the mechanical limitations of each particular die. The large, complicated ones, with a great many cores to operate, are of necessity slow. The small, light ones are correspondingly fast.

Figs. 11*a* to 11*c* show a four-impression die for a faucet part demands a closer tolerance, the running of a threading die over the threads will bring them to the desired size. As these threading dies take but a slight shaving cut in this case, they operate at a high speed on an automatic threading machine.

The two dies illustrated in Figs. 8 and 11 are comparatively simple. However, the larger and more complicated ones employ the same principles of construction and operation. In most cases, when designing a part to be die cast, it is desirable to eliminate all undercuts. By this is meant having each core removed from the casting and also the casting removed from the die, intact, and in one straight line. This is the simplest manner in which to produce die castings.

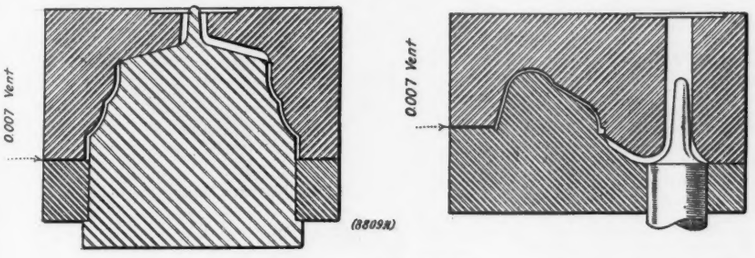
In some cases where undercuts are essential, a large number of castings will justify the additional expense of collapsible cores and other complicated die constructions.

What kind of material will make the best dies? How long will these dies last? These are two questions which metallurgists are endeavouring to answer. In the case of a die for lead or tin, a good grade of carbon machine steel will last indefinitely. The heat that passes from the casting into the die is not great enough to affect the steel. In the case of zinc castings, which possess more heat to be absorbed, the additional heat strains the steel more severely. After about twenty-five thousand castings a carbon-steel die develops small surface cracks which are the result of the thermal fatigue of the steel. Aluminium with its higher melting point causes a more drastic action. Using a special alloy steel, properly heat treated, these dies develop heat cracks after from 5,000 to 15,000 castings, depending on the size and shape of the casting. However, the useful life of these dies varies from 25,000 to 200,000 casting operations.

Fig. 12 illustrates what takes place to cause these cracks. The heat from the molten metal when injected into the die raises the entire impression surface A to within a few degrees of its own temperature. This increase in temperature tends to make the die expand in all three dimensions. The tendency for a small portion of the steel block would be to expand to a shape similar to the dotted lines at x in the figure. The cooling effect of the water lines at B keeps the under portion of the die within a few degrees of the temperature of the water. These portions do not expand. As the small element of steel shown at x cannot expand horizontally because it is in the centre of a steel block, it expands to a shape similar to the dotted lines at y. The upper portion of the element at C will be under a compression strain. After the casting leaves the die and before the next charge of metal enters, the impression surface of the die cools somewhat, relieving this compression strain.

Causes of Heat Cracks in Dies.—These periodic strains occur many times an hour. Eventually the impression surface becomes permanently deformed and the element of steel, during the cooling period of the cycle, tends to assume a shape as illustrated at z in Fig. 12. For a steels that their life is very short. The castings are successful, but the cost of the die prohibits the production of so few castings. If a substance could be found that would produce an indefinite number of aluminium castings without the annoyance of thermal fatigue, the same substance would commercially produce brass castings. At present no such substance is known and the prospect of finding one in the near future seems very improbable.

Defective Castings.—Blowholes (gas bubbles or pockets in the casting) are a very common fault. These imperfections reduce the strength of the part and, if they occur on the surface, mar its appearance. The causes of these defects may be classified as dross or slag, porous metal, improper venting of the die, improper gating of the die, and "piping." A certain amount of slag finds its way into the castings. However, failures due to its presence are so few that they may be disregarded. Metals in the molten state absorb a certain amount of gases from the air. These gases pass into solution in the metal. When the metal solidifies, the gases, as they are not soluble in the solid material, go out of solution, forming micro-



Figs. 9 & 10. METHODS OF VENTING AND GATING DIES

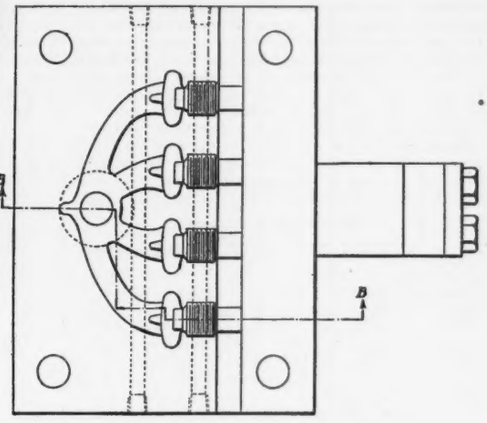


Fig. 11b. COVER DIE FOR A SCREW FAUCET PLUG

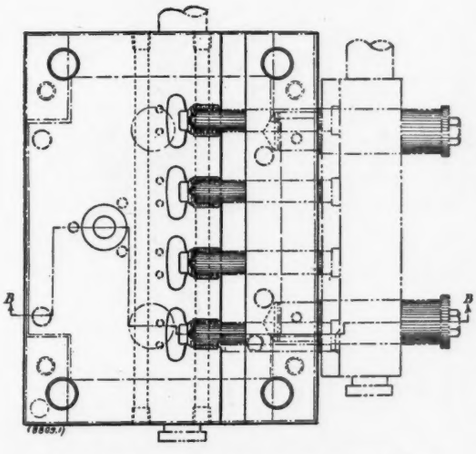


Fig. 11a. EJECTOR DIE FOR A SCREW FAUCET PLUG

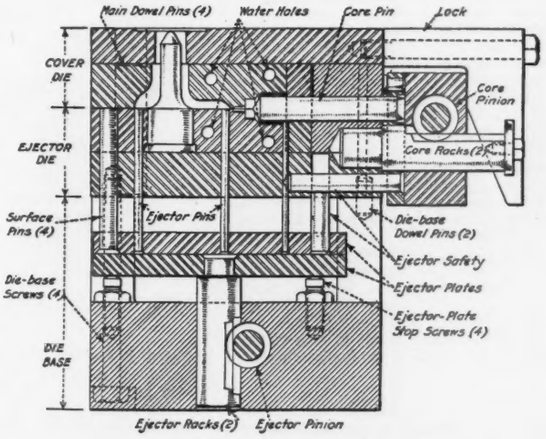


Fig. 11c. SECTION *B-B* OF FIGS. 11a AND 11b

while the tensile strength will hold the element to the shape at y. Finally the surface gives way, the elements assuming a shape similar to that at z. This leaves a crack between this element and the adjacent one. These fine hairline cracks spread over the surface, forming a network of these crevices. The succeeding shots of molten metal wedge their way into these cracks, aggravating greatly the thermal action.

The presence of these cracks in the die causes corresponding ridges in the casting. Such dies may continue in use until the cracks are so large and numerous that it is not economical to remove the resulting fins from the castings. Upon the size and bulk of the casting depends the rapidity with which the die will crack. The size to which these cracks may safely grow depends upon the duties which the castings will perform.

The problem of eliminating this fatigue failure seems to require a die material whose elastic limit is high enough to prevent the temperature changes from stressing the material sufficiently to cause permanent deformation. Such conditions may be had by raising the elastic limit, decreasing the coefficient of expansion, or by a combination of both.

If these changes could be carried far enough, brass castings could be economically die cast. The heat action of the brass is so drastic on the present die

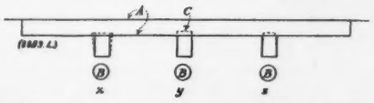


Fig. 12. DIAGRAM ILLUSTRATING CAUSES OF HEAT CRACKS IN DIES

scopic pores. Due to their small size they are not objectionable. Naturally, however, in order that the material may be as solid as practicable, it is desirable to have as few of these pores as possible.

Experiments show that the hotter the metal while melting the longer it remains molten, or the hotter it is during the casting operation the more porous will be the solidified material. It is therefore desirable to melt the alloys at as low a temperature as possible, keeping them melted as short a time as possible. Lastly, it is desirable to cast the material at the lowest temperature at which it will flow properly into the mould. By these precautions we decrease the porosity to some extent and consequently increase the strength. If the die impression has not a proper vent, part of the air in it becomes entrapped in the casting. In some cases the location of the gate causes the metal to flow through a thin section of the impression into a larger portion. The metal in the thin portion of the casting is very apt to solidify before the larger portion fills. This leaves the large section of the part incompletely filled. In the section dealing with dies several cases of proper gating have been illustrated.

Piping or the formation of shrinkage voids, as in other methods of casting, usually starts in the gate and tends to extend to the casting. If pressure is maintained in the casting chamber so that new metal can be forced into the die as that which is already in it shrinks, the chances of piping within the castings will be reduced to a minimum.

Study and experiments conducted with that purpose in view will eliminate the objectionable features of these defects from practically any casting.

Inserts.—Certain portions of many castings are required to have specific properties other than those of the die-casting materials. A material possessing the desired qualities, if placed in a die, will form an integral part of a casting after the molten metal solidifies. In this way portions of the casting may be provided with local properties that the die-casting alloys cannot furnish.

In Fig. 13 two bronze inserts, placed end to end, form a bearing through the centre of the casting. These inserts furnish a far better bearing surface than would be the case if the aluminium were used throughout.

Figs. 14, 15 and 16 illustrate the use of tubing. In Figs. 14 and 16 the tubing forms a passage too small and crooked to be cored with a steel core. The end of the tube projecting from the lower portion of the casting in Fig. 15 brazes or solders more readily than the alloy composing the remaining part of the gauge. The soft-iron pole pieces, shown at A in Fig. 17, provide certain magnetic properties that the casting itself does not possess. The inserts at B of this same casting, after being drilled and tapped, furnish a more durable thread than would the zinc-base alloy of the casting.

Through the use of inserts similar to those illustrated, the usefulness of the industry far exceeds the possibilities of the products made from the unaided casting materials.

Conclusion.—The construction of the die places a high initial cost upon the product. If only a few castings are required, the cost of the die will be prohibitive. However, if a large number of castings is desired the cost per part dwindles to a very low figure. Starting with this fundamental principle, die casting is most advantageous where many castings are required. The process is most economical where its close casting tolerances eliminate machine operations that would be necessary on castings from other processes. Thus the money saved on a large order more than compensates for the cost of the die. This process cannot compete with sand castings that require little or no machining. In a similar way it cannot compete commercially with simple sheet-metal stampings and simple screw-machine parts. The rapidity with which automatic and semi-automatic machines turn out these two classes of products reduces their cost to a minimum. In general, the initial cost of the die for die casting the same parts eliminates this method for those types of work. The products of die casting are constantly becoming larger and more complicated. At the present time the die casting of automobile body frames is contemplated. In the near future the industry will probably be enlarged to include such castings as crankcases. Such parts will require the construction of new and larger casting machines.

To-day the die castings of a few years ago seem very simple. No doubt many of the castings of the present will assume a similar aspect to the engineers of a few years hence. Die casting is a young, growing industry whose possibilities can only now be surmised.

DIE CASTING.

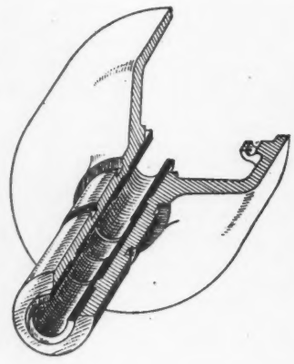


Fig. 13. Base Casting for an Ignition Unit

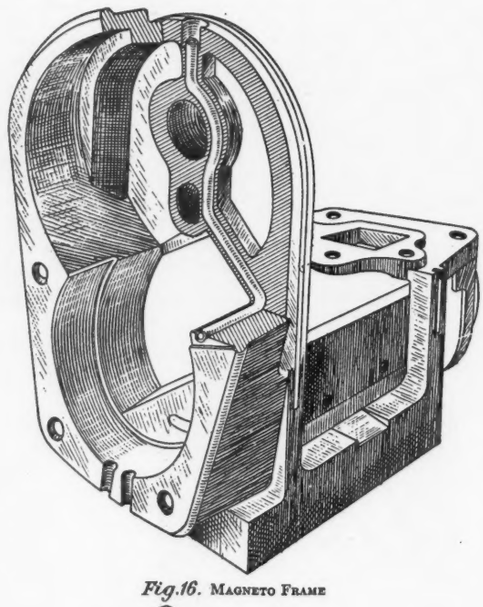


Fig. 16. Magneto Frame

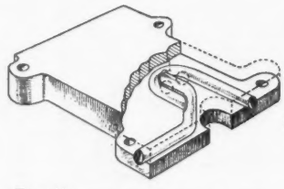


Fig. 14. Valve Block For a Vacuum Windshield Cleaner

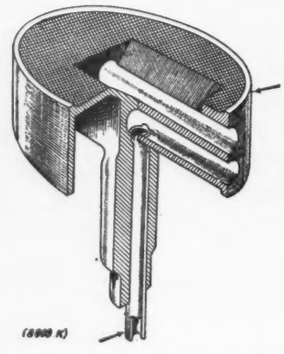


Fig. 15. Automobile Dash Gage

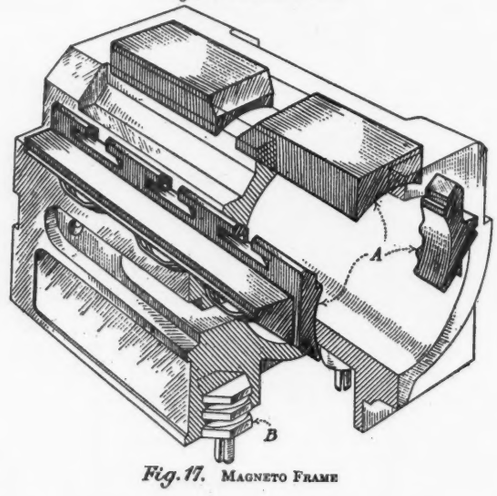


Fig. 17. Magneto Frame

NOTES ON NEW BOOKS.

Elementary treatises on foundry work are now frequently appearing, perhaps because students are developing an awakening interest in this subject. This is doubtless a result of the growth of the technical side of the craft which has been fostered by the activities of the technical schools and by the investigations of the metallurgists. Very little, of course, of practical value can be taught within the limits of 124 pages, and in such a case it is the more necessary to make a judicious selection of matters that are of cardinal importance, since it is impossible within so limited a space to include more than the barest outlines of the immense number of examples that call for daily exposition in the foundry. A manual can be little more than a precis, and must be written by a man of practice who has worked long at his craft, and is able to go to the heart of his subject, and discuss its essentials. Such a book we are pleased to see is "*Moulding and Other Foundry Work*," by Mr. William Bell (Constable and Co., Limited, price 3*s.* 6*d.*). Few examples of actual moulding can be given, but the underlying principles are lucidly stated, and the characteristics of the materials, appliances and methods used are described with suitable condensation. Sands, metal, coke are embraced in the first section; boxes, chains, ladles, ropes in the second; the third deals with the main divisions of moulding, green, and dry sand, loam, and cores. Around these are discussed the problems that concern runners, shrinkages, venting, liquid pressure, the securing of cores. Seventy-one judiciously selected sketches illustrate importants points. The student who assimilates the contents of this volume will have acquired a good idea of the fundamentals of the moulder's craft.

When Dr. Ing. Robert Garbe brought out, in 1907, his large treatise on the "Dampflokomotive der Gegenwart" he wrote as the champion of superheated steam for railway engines. In the second (1920) edition of this work he had to report progress and to rewrite, but the cause had been won. In his new volume, "*Die Zeitgemässe Heissdampflokomotive*" (Berlin: Julius Springer, price 3·35 dols., bound), which forms a supplement to the second edition of 1920, he is once more taking up arms, this time against modern tendencies in locomotive design of which he does not approve. The adjective *zeitgemäss* is not easily translated; it means "according to the requirements of our time." Dr. Garbe was one of the first advocates of unification and simplification in the types of railway engines and their parts; but he considers that the modern movement of standardisation goes too far. The demand for high speeds led to the adoption of the four-cylinder engine, advantageous he considers, for light, fast trains, but uneconomical for fast running with heavy trains. For general passenger traffic and for freight trains he prefers two-cylinder engines. He is not alarmed by the necessary higher piston loads and the increased stress on the crank-pin. During the war economical considerations had to be disregarded in the interests of high carrying capacity. But war types should not be stereotyped for peace conditions, and Dr. Garbe does not think that some popular types are really ripe for standardisation. The new, small quarto, volume of 167 pages, very well illustrated, is divided into five parts. The first part reviews recent progress. The second, on the relations between grate area and heating surface, deals with recent researches by Dr. Garbe. Economy in steam production and superheating compatible with small dimensions, he argues, calls for high combustion temperatures, and for a minimum superheater area and maximum heat transference. These considerations are carried further in the fourth part which deals with road tests. The combustion in the firebox, firing with solid fuels and the differences in the working of stationary and portable furnaces, are discussed in the third part. The general conclusions drawn in the fifth part rely perhaps a little too much on road tests, which hardly allow of settling design problems. Germany had no complete locomotive testing plant before the war; neither has it yet got one. The Altoona plant of the Pennsylvania Railroad, to which Dr. Garbe refers, still stands alone in the production of test data on large modern engines.

Those interested in the doctrine of relativity will welcome the reprint, by Messrs. Gauthier-Villars and Cie., Paris, of four lectures on the "*Théorie de la Relativité*," delivered at Princetown University, by Professor Einstein. These have been translated from the original German into French by M. Solovine, and are thus rendered accessible to the many who are either unacquainted with German, or read it only with difficulty. The lectures were intended to serve as an introduction to the subject for those who have a knowledge of the elements of higher mathematics, but who have no great surplus of time or of energy to devote to the study. The price of the volume is 17 francs. The same publishers have also issued, at 6 francs, a translation by M. Solovine, of Professor Einstein's essay on "*L'electrodynamique des corps en mouvement.*" It was in this memoir, published in 1905, that the author first brought forward his restricted theory of relativity, and came to the conclusion that the hypothesis of a luminiferous ether was unnecessary. Here results already published by Lorentz were arrived at, but in a very different and more general way, and the author at the time of publication, had no knowledge of the work of Lorentz. The publishers and the translator are to be congratulated on making this important pioneering essay available to all readers of French.

The work of the early pioneers in the microscopical investigation of iron and steel, and in researches concerning the behaviour of specimens of these metals under varying temperature conditions, had its origin in the investigations made by Sorby in the early 'sixties of last century; the work has been followed up since by a large number of scientists. The results which all these investigators have achieved and are still achieving, form a most valuable aid to every-day manufacture in all its phases. Shortly after Sorby made public the result of his researches, Gore, in 1869, made known the phenomenon of recalescence which he had observed to take place during the cooling of steel. Four years later Barrett discovered that the reverse effect occurred during heating, at approximately the same temperature. The pyrometer next provided the means of accurately measuring high temperatures. All these discoveries have contributed together to

form the section of metallurgy known as metallography. This comparatively new science is dealt with in "*Practical Microscopical Metallography*," a very interesting and very carefully got-up treatise, by Dr. R. H. Greaves, and Mr. H. Wrighton, B.Met., both of the Research Department, Woolwich, published by Messrs. Chapman and Hall, Limited, 11, Henrietta-street, London, W.C.2 (price 16*s.* net). After a brief historical chapter by way of introduction, the authors give very complete practical instructions for the preparation of specimens previous to their examination under the microscope, instructions which will be greatly appreciated by students, amongst other readers. Then follow particulars concerning the microscope and microscopical examination. The greater part of the book is devoted to the consideration of the structure and properties of metals, the effect of various treatments, of non-metallic inclusions, defects and impurities being gone into in detail. After each chapter are given practical notes concerning the preparation and examination of specimens of the metals dealt with in the chapter. Besides constitutional diagrams and other illustrations, the book contains 182 admirable microphotographs, the characteristic features of which are entered into. The book in every page gives evidence of having been prepared with extreme care; it is very readable, and considering the important part now played by metallography, it will greatly interest a wide circle of men whose business brings them into constant contact with the new methods of treating and examining ferrous and non-ferrous metals.

Coal tars differ so much in their compositions according to the conditions under which they were produced, and the analyses and separations of the highly complex mixtures are so difficult that ordinary reports upon the products of a carbonisation process do not attempt to specify more than that distillation resolved the tar into fractions of certain boiling ranges and properties. But coal tar, originally a nuisance, then a source of wealth to the dye chemist, has become one of the most important raw materials for the engineer as well, and its value fluctuates greatly with the demand for certain of its constituents. If only a small fraction of the hopes now entertained be realised, ultimately very little coal will be burnt directly, and nearly all will be carbonised first, to yield its valuable tar. In any case, a rapid development of the tar industry may be reckoned upon, and books like "*The Constituents of Coal Tar*," by Dr. Percy E. Spielmann, F.I.C. [London: Longmans, Green and Co.; price 12*s.* 6*d.* net] may be expected to be much in demand. Dr. Spielmann describes the diverse derivatives of tar, their preparation, properties, reactions, toxicity and uses. He does not go into synthetic processes, but he gives a very welcome summary of available data on the very large number of tar compounds, which he has, by painstaking research, collected from a widely-scattered literature. The numbered bibliographical references testify to his conscientiousness. Dr. Spielmann wrote last year a book on the "*Genesis of Petroleum*," which was well received.

Books in which the problems of the engineer and physicist are worked out are useful, provided the explanations given be adequate. In some cases, unfortunately, the so-called solved problems are little more than reprints of examination papers to which some explanatory hints are added. This charge cannot be made against the "*Aufgaben aus dem Wasserbau*," by Dr. Ing. Otto Streck (Berlin: Julius Springer, price 2·75 dols., bound). The well-selected examples of problems of hydraulic construction, taken mostly from recent installations, are fully explained and numerical values are deduced, sometimes by several of the available formulæ. Typical problems dealt with comprise hydrostatic pressure on sheet piling, buoyancy of caissons, flow and pressure of water in open conduits and in pipes, syphons, back pressure and water hammer, catchment area calculations, water discharge through sluices and over weirs, water power calculations in rivers carrying detritus, etc. The treatment accorded to each case requires much space, and Dr. Streck only deals with forty problems in this illustrated volume of 362 pages. Some space might have been saved, both by the author and the printers.

The distinguishing characteristic of the "*Structural Engineers' Handbook*," of which a third edition has just been published by the McGraw-Hill Book Company, Inc., of 6 and 8, Bouverie-street, London, at 35*s.* net, is the wealth of illustration of details and the very exceptional completeness of the accompanying letterpress. The book is much more than a text-book on stresses. Indeed, although stress determinations are dealt with adequately for nearly all practical purposes, considerably more space is given to the discussion of the object and nature of structural parts. Representative standard specifications for bridges and architectural steelwork are also included. The author has further embodied in his work the "Instructions to Draughtsmen" drawn up by the engineering department of the Chicago, Milwaukee and St. Paul Railway. Considerable space is devoted to estimates and costs, and the section dealing with the erection of structural steel includes many pages of illustrations of the various tools used. A comprehensive series of tables giving the properties of various structural sections concludes the volume, which extends to over 1,000 pages of text, and contains hundreds of engravings. The author is Professor M. S. Ketchum, M.Am.Soc.C.E., Dean of the College of Engineering and Director of the Engineering Experimental Station of the University of Illinois.

In June, 1921, the Russian Government appointed a patent commission in order to bring the preliminary patent law of 1919 into line with the altered regulations concerning imports from other countries and with trade concessions. The report of the commission was approved by the Executive in September last, and the preface to "*Das Neue Russische Patentgesetz*," by Professor I. J. Heifetz, is dated a fortnight later. Professor Heifetz is a trained engineer and patent lawyer of Leningrad. This volume of 116 pages, which Dr. Hellmut Rost of Berlin has translated into German (Berlin: M. Krayn; price 4 marks), forms the last chapter of Heifetz's Russian treatise on "The Principles of Patent Legislation." Though Mr. L. Martens, President of the Russian Patent Office, has written a preface to the pamphlet, Professor Heifetz admits that the new patent law bears, in certain inconsistencies, evidence of the changes which the Russian views of questions of national economy have undergone in the last few years. But he considers that the law is well suited to serve the interests both of the inventor and of the country, and he pays particular regard to the trading rights of foreigners. According to the 41 articles of the new patent law, and the further regulations on trade marks, &c., a patent is only granted to the real inventor (or his legal heirs) for a new process; chemical products, medicines, &c., are not patentable, but the processes are, if fully described. A distinction is drawn between additional patents, only granted to the original inventor, and improvements for which any third person may apply; the distinction also affects the invalidation. A patent may be taken out by an employee and always remain his; it may be transferred to his firm, but only when there is a previous agreement to this effect, and when the firm is already engaged in the particular line. The patentee must work his process personally or by licence. The State may claim any important invention, not only for reasons of national defence, and may in general grant licences to others if the patentee neglects his obligations; the patentee may, however, import his own articles to a limited extent. There is a preliminary examination before the application is published, and an expert examination before the patent is sealed. But—a very striking feature—no fees are due before the process is actually worked; the fees rise from 5 roubles in the first three years to 75 roubles in the tenth year and more for the full period of 15 years, which may be extended. Foreigners share, as regards patents and general laws, the rights of Russian citizens, but licences are restricted to the latter, and foreigners, like citizens, can only work factories, mines, &c., with more than 20 hands, by permission. The monopolies conferred by the old Russian patents were cancelled in 1919; new patent applications have to be made, but the old documents are to be taken into consideration without being regarded as anticipations.

In describing the night march that was necessary to bring the English force into position at the Battle of Tel-el-Kebir, it was currently reported at the time that Sir G. Wolseley availed himself of the services of a naval officer, the army being unable to provide one sufficiently trained in starcraft. Doubtless that is altered now, for much practical experience has shown the necessity for technical training. Major Molesworth, however, thinks that the training might be of benefit to a larger number, and General Birdwood, who supplies a foreword to his book, "*The Military Uses of Astronomy*" (Longmans, London, price 3*s.* 6*d.*), evidently agrees with him. But Major Molesworth might well seek a larger audience than the army can supply. The information, which he suggests might be useful to the military, was the common possession of all before mechanical contrivances superseded the use of intelligence and observation. The heavens present a perpetual clock for those who would recover the lost lore that guided the men of old time, giving direction to all, who wish for a signpost that will not mislead. The few facts and inferences that the author produces here should be the possession of every intelligent man, though he may never be called upon to guide a company over the trackless desert or find a road through bush and scrub. The author has had one definite purpose before him: to enable an officer to acquire for himself all the practical information he requires. He shows how angles may be measured without theodolites, how the stars may be identified, wisely confining himself only to the more conspicuous, and how time is, or might be, determined and measured. A chapter is given on tides, of which all we can say is that we hope it is true; it certainly follows recognised authorities, but seems scarcely relevant to the case of a tidal estuary. The altitude diagrams given in an appendix are likely to be useful and add to the lucidity of the explanations furnished in the text. The book is well printed and we have noticed only one slip. The earth's axis is inclined to the ecliptic at an angle of 66½ deg., not 23½ deg., as stated on page 20.

CATALOGUES.

Telephones.—The Millerphones Company, 79, Holborn Viaduct House, London, E.C.1, have sent us circulars of their private telephones.

Laundry Machinery.—A wall sheet illustrating washing, hydro-extracting, ironing, and drying machinery is to hand from Messrs. Manlove, Alliott and Company, Limited, Nottingham.

Valves.—Messrs. J. Blakeborough and Sons, Limited, have sent us a copy of a reprint of an interesting description of their works at Brighouse, Yorks, at which valves from ¼ in. in diameter to 94 in. in diameter are made.

Baths.—A further issue of the little pamphlet explaining the construction of baths at the pit head for miners is to hand from Messrs. Gummers, Limited, Rotherham, and the Brightside Foundry and Engineering Company, Limited, Sheffield.

Power Station Equipment.—The General Electric Company, Limited, Magnet House, Kingsway, London, W.C., have issued a 4-page illustrated sheet describing the extensions carried out by the company for the Stoke Newington municipal electricity undertaking.

Printing Machine Repairs.—Messrs. R. W. Crabtree and Sons, Limited, 7, Farringdon-road, London, E.C., have sent us a circular relating to the maintenance and repair of all kinds of printing machinery and illustrating one of their large rotary printing and folding machines.

Cooking Plant.—A catalogue of large ranges, steam ovens, steam-jacketed boiling pans, heated carving tables, tea and coffee-making apparatus, &c., representing the application of this branch of engineering to large establishments has reached us from the Brightside Foundry and Engineering Company, Limited, Sheffield.

Oil Separator.—A vessel for separating oil from exhaust steam is the subject of a special catalogue received from the Steam Fittings Company, Limited, West Drayton, Middlesex. The eliminating device is automatically vibrated by the passing steam, thus preventing the oil from clinging to the surfaces and rendering the apparatus self-cleaning.

Electric Motors.—Messrs. Brittains Electric Motor Company, 110, Cannon-street, London, E.C., have issued a circular relating to their alternating-current motors, hand-operated friction clutches, &c. The motors conform to the B.E.S.A. specification. The firm undertakes repairs in a special department lately established for this particular work.

Mechanical Stokers.—A full description, with general and detail illustrations, of the Harrington stoker appears in a catalogue issued by the Riley Stoker Company, Limited, Palace Chambers, Bridge-street, London, S.W. The application to various water-tube boilers with air preheaters and re-heaters for the partially expanded steam is very clearly dealt with.

Laboratory Furnaces.—Several designs of laboratory muffles, with rectangular, oval and tubular chambers, a crucible muffle, high-temperature resistor furnaces, control panels, and the Richardson lamp are shown in a catalogue received from Messrs. Townson and Mercer, Limited, 34, Camomile-street, London, E.C. Adequate descriptive notes and prices are given.

Valves.—The Ismailia valve for water, oil, sewage, and general use, is a flap valve made of two castings, which act together without pins, bolts, or connections. The designer and patentee is Mr. E. C. Bowden-Smith, 17, Victoria-street, London, S.W., and the valves are made by Messrs. J. Stone and Co., Limited, Deptford, London, S.E. They were illustrated and described in ENGINEERING, vol. cxvi, page 392.

Manganese Steel.—An explanation of the peculiar qualities of manganese steel and its application to special rail and tramway tracks; dredging, crushing, conveying and other machinery; the manufacture of safes, &c., is given in the second edition of the pamphlet issued by Messrs. Edgar Allen and Co., Limited, Sheffield, who supply parts finished by grinding, this steel not being amenable to the action of cutting tools.

Power and Heat.—A new edition of their catalogue of steam engines adapted for the supply of heating steam has been issued by Messrs. Belliss and Morcom, Limited, Birmingham, who have given close attention to this means of reducing the cost of power and heat together. Very striking figures are quoted of a simple expansion two-cylinder engine working on superheated steam at 150 lb. pressure and exhausting to the heating mains at 50 lb. pressure. The catalogue contains a great deal of valuable information on this matter.

ELECTRIC HEATER FOR SANDING GEARS.

WE illustrate on this page a universal electric sand pipe heater, designed to keep the sand pipes on locomotives, street cars and the like free from clogging at their lower end, during spells of cold and wet weather. In such climatic conditions, the lower end of the sand pipe is always wet, and it is well known that dry sand will not flow from a wet pipe without particles of sand sticking to the side of the pipe, and eventually closing the outlet. The function of the device we illustrate is to keep the orifice dry, thus ensuring a flow of sand at all times and securing thereby full tractive effort and maximum adhesion for braking when needed.

The device is shown in place in Fig. 1. It is simply screwed on to the lower end of the sand pipe, the method of mounting being set forth in fuller detail in Figs. 2 and 3. The nature of the fitting will, however, be best understood on reference to Fig. 4, where the main casting of the heater is shown as partially cut away, so as to make visible its interior. In the annular space between the casting and the sand pipe room is found for a few turns of insulated wire arranged as indicated. Current from the head light generator is passed through these coils, and warms up the end of the sand pipe sufficiently to keep it dry in all weather conditions. So far, two sizes of the heater have been fitted, of which the smaller takes 64 watts and the larger 80 watts.

Laboratory tests on the device were recently made by a large eastern railroad in the United States. Pipes were set up as on a locomotive, complete with sand box and valves for sanding the track. Water was allowed to trickle down the pipe and a blast of air equivalent to a cross wind blowing at 30 miles an hour was projected against the end of the sand pipe. Sand was allowed to flow down the pipe every 10 seconds. With the heater out of use, the pipe closed up in from 5 to 15 minutes, but on turning on the current, there was no accumulation of wet sand in the lower end of the sand pipe at the end of an hour and 15 minutes. At a later date a road test was made. A 5-gallon can of water was placed on the running board of a locomotive and a hose extending down to a point near the lower end of the sand pipe, was used to trickle water on to the pipe. In making a 50-mile run without the current turned on, the pipe clogged in five minutes, having to be cleaned out constantly. On the return trip, the current was turned on and the pipe gathered no wet sand. Still another test was made in the freezing room of the Penn Cress Ice Cream Company at Cresson, Pa., U.S.A. The sander was operated at a temperature of zero, with water trickling on to the sand pipe. This was continued for two hours, but with the heater in operation, no clogging occurred under even this drastic test.

A dependable flow of sand is, of course, of great importance in railway working, ensuring the easy starting of trains, and preventing the over running of platforms.

Mr. C. B. Johns, of Ebensburg, Pa., U.S.A., who has been running a locomotive on the Pennsylvania Railroad for some years, is responsible for the design of the apparatus, which is manufactured by The Universal Sand Pipe Heater Company, 1536 Commercial Trust Buildings, Philadelphia, Pa., U.S.A.

ELECTRIC HEATER FOR SANDING GEARS.

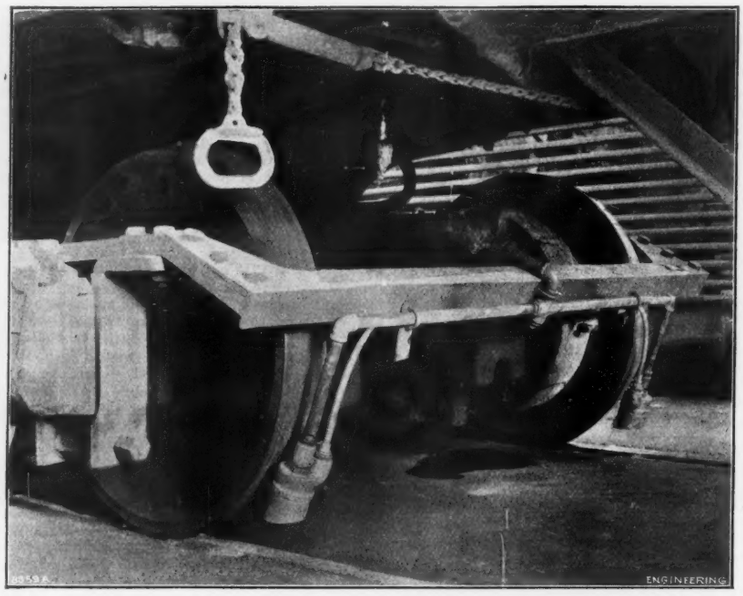


FIG. 1.

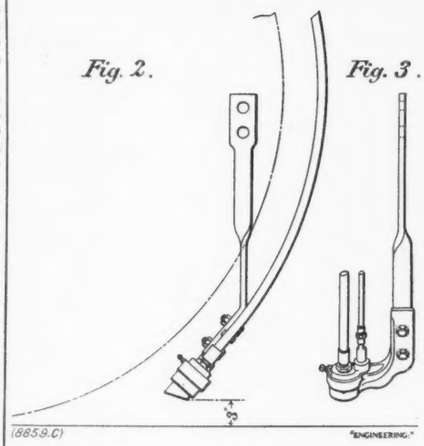


FIG. 4.

AUSTRALIAN IMPORTS AND EXPORTS IN OCTOBER.—The total values of the goods imported into and exported from Australia during the month of October, 1924, were £12,687,511 and £15,015,456 respectively.

SPEED OF MOTOR CARS.—The Ministry of Transport has presented to Parliament a Return showing the regulations in force in the principal European countries with respect to the speed of motor cars. Copies of this Return may be obtained at His Majesty's Stationery Office, price 4*d.* each.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—It is announced that an examination will be held on April 2, 3, and 4, by the Institution of Electrical Engineers, the passing of which will constitute a qualification for the grade of associate membership. Candidates must be either students of graduates of the Institution, or have lodged a duly completed form E with the Secretary, the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C. 2, who will provide entry schedules for the forthcoming examination. These must be returned to him by February 1.

NEW REGULATIONS FOR THE REGISTRATION OF MOTOR VEHICLES.—New provisions regarding the registration and licensing of motor vehicles have been put into force since January 1, by the Ministry of Transport. Under them a newly acquired vehicle may be registered initially in the district in which it is purchased, and the transfer to the district in which the car is to be kept ordinarily will be made by the authorities. Another alteration relates to the procedure when the ownership of a vehicle is changed. The registration book must in future be handed over with the vehicle, and after it is signed by the new owner be sent to the borough or county council, with whom the car was last registered. The previous owner must notify the authorities that the car has passed out of his control, when a new registration book will be issued. Certain minor changes have been made in regard to the painting of identification and Hackney carriage marks. Number plates with detachable letters or figures are now prohibited.

TRUNK ROADS IMPROVEMENTS.—The roads policy of the Ministry of Transport has recently been extended in a somewhat new direction. Recognising the necessity of dealing comprehensively and consistently with the great trunk lines of communication which hitherto have been handled in a more or less piecemeal fashion, the highway authorities of the country have been invited to collaborate with the Ministry in the modernisation of a certain limited number of principal routes selected as main lines of national communication, *e.g.*, the Great North-road, the London–Holyhead-road, the Bath-road, the Perth–Inverness-road, and seven or eight others of similar importance. On condition that the normal programme of road improvement in each area shall proceed unchecked, the Ministry is making exceptionally generous grants towards these trunk road schemes which will provide useful employment for considerable numbers of men during the coming eighteen months. In the aggregate, the Ministry's contribution from the Road Fund will reach 5,000,000*l.*, and agreement has already been reached, with the County Councils concerned for the execution of numerous items in the programme. Among others, definite approval has been given to works proposed in the North Riding and West Riding of Yorkshire, Northumberland (between Morpeth and Alnwick), Kent (between Maidstone and Charing), Hampshire (in the neighbourhood of Basingstoke). A large staff of engineers specially appointed for the purpose is busily engaged all over the country in the preparation of surveys for other sections of route, so that full particulars and estimates will shortly be ready for submission to the highway authorities and the Ministry of Transport. The undertaking upon which the Ministry is now entering goes far beyond the mere improvement of the surfaces of the old highways. Where the alignment or grading is defective or the sight-line dangerously restricted, widenings, clearances and re-gradings will be effected. Where the road is perilously cramped by clusters of buildings which cannot be set back, a new highway will in several cases be swung round through the open country, leaving the old road for the use of the local residents. In many instances, proposals of this character will have the effect of preserving ancient structures and charming villages which might otherwise be threatened by road widenings. As an illustration may be quoted the village of Wansford, on the borders of Huntingdonshire, where the Great North-road has to negotiate a level-crossing over the railway, various sharp bends, a dangerous cross-roads and a delightful old stone bridge, well adapted for mediæval traffic, but strikingly inadequate for modern needs. All these potential dangers will be avoided by the creation of a by-pass with new bridges over the railway and the stream, and a good modern road simultaneously secured.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

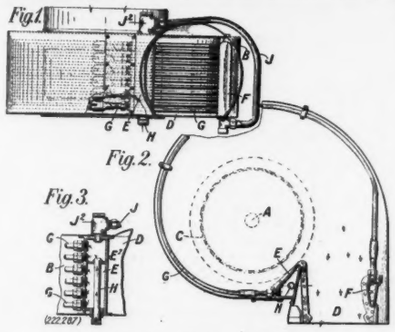
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

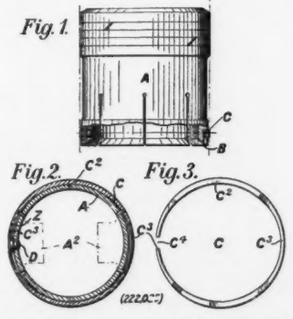
GAS ENGINES, PRODUCERS, HOLDERS, &c.

222,287. Armstrong Siddeley Motors, Limited, Coventry, and F. R. Smith, Coventry. Oil Coolers. (3 *Figs.*) August 23, 1923.—The invention relates to means for cooling the lubricating oil of internal-combustion engines, such as are used on motor vehicles. For cooling the engine there is employed a fan arranged in a casing, which is generally snail-shaped when seen from the direction of the axis of rotation of the fan, and, according to the invention, there is located at each side of the outlet from the casing an oil header, and pipes extend from the one header to the other around the inside wall of the casing. The oil is supplied to the one header and flows through the pipes to the other header, being cooled in transit. Preferably each header is divided by baffles, so that the oil flows backwards and forwards from the one header to the other. The fan (not shown) has a vertical axis A, and the casing B is snail-shaped when seen in plan, with a central vertical aperture over the centre of the fan which serves as the



air inlet C. The air flows horizontally out of the casing at D and is directed on to the engine. In both vertical walls of the outlet are arranged headers E and F, and both of these are divided by baffles (such as E^2, Fig. 3). To the headers are attached pipes G, which extend round the inside of the casing, and each pipe is branched close to the header and is duplicated, as is shown in Fig. 1, so as to reduce the number of connections and yet provide a large surface area for cooling. The baffles are so constituted that the oil cannot flow solely in one direction, but flows by the inlet pipe H, Fig. 3, to the top of the first header E round the casing to the top of the second one F, back to a lower part of the first, returning to the second at a lower point thereof and so forth, any suitable number of times, so that the distance of its travel is very considerable and the cooling effect very great. A by-pass pipe J, controlled by a spring-loaded valve contained in the valve-box J^2, connects the headers E and F. (*Accepted October* 8, 1924.)

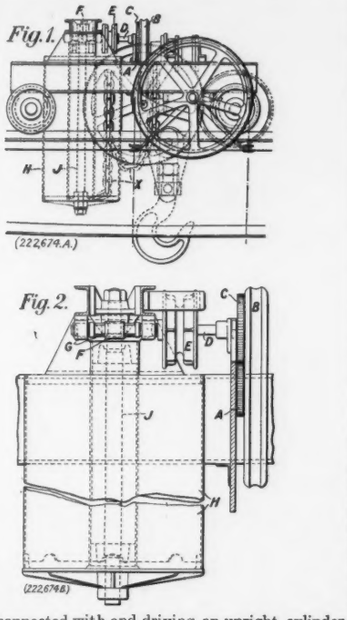
222,062. A. H. M. J. Ward, Mereworth, near Maidstone. Pistons and Piston Rings. (4 *Figs.*) October 13, 1923.—The invention relates to pistons and piston rings for internal-combustion engines of the kind in which there is an external groove near the bottom of



the skirt in which lies a ring which bears against the bottom of the groove as well as against the cylinder wall. According to the invention, the bottom of the groove is concentric, and the ring is made thinner on those parts which lie on the non-pressure faces of the piston. The piston A is formed at the lower part of the split skirt with a groove B in which lies the bearing ring C. The exterior of the ring is of the same diameter as the bore of the cylinder, but the internal periphery of the ring is not circular, as is best seen in Fig. 3. At the points C^2 the ring is thicker than at the points C^3. The points C^2 are adapted to lie upon the pressure faces of the piston, that is to say, those faces which receive the side thrust of the connecting rod. As will be seen from Fig. 2, the points C^2 lie between the gudgeon pin bosses A^2. The thin parts C^3 consequently come on the non-pressure faces, and there is a clearance between the back of the bearing ring at these points and the bottom of the groove indicated at Z, Fig. 2. The ends of the ring, which are split at C^4 as usual, engage a peg D which prevents rotation of the ring and ensures the thickened portion C^2 remaining always on the pressure faces. (*Sealed.*)

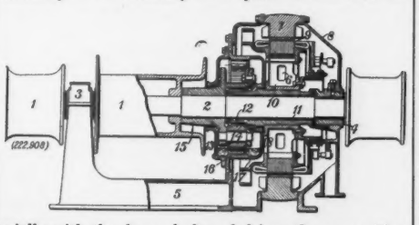
LIFTING AND HAULING APPLIANCES.

222,674. Herbert Morris, Limited, Loughborough, and G. T. Smith, Loughborough. Lifting Gears. (2 *Figs.*) October 6, 1923.—The invention relates to lifting gears. The device of the invention consists essentially of a rotating box into which the slack portion of the load chain is led, with operative mechanism for rotating the box during the rotation of the main load wheel. The rotation of the box is so proportioned to the speed of the chain that the slack chain falls into it in a successive series of small piles filling the box. There is geared to the spur wheel A attached to the main load wheel B, a spur wheel C mounted on a shaft D carrying a pocketed chain wheel E. A worm F, which is integral with the shaft D, meshes with a worm



wheel G connected with and driving an upright cylinder or box H, which is mounted so as to rotate on a fixed spindle J. The slack end of the load chain X, which is attached to the bottom of the circular box as indicated in Fig. 1, passes over the pocketed wheel E, and hangs in a short loop between this wheel and the main load wheel B. In this case the load wheel B consists of a worm wheel and a pocketed chain wheel, the latter portion of which is not shown in the drawings. The gear ratios are so proportioned that the chain is led into or out of the box at exactly the same rate as it passes over the main load wheel. The rotation of the box is such that the chain falls into the box gradually filling the whole of the space therein.—(*Accepted October* 15, 1924.)

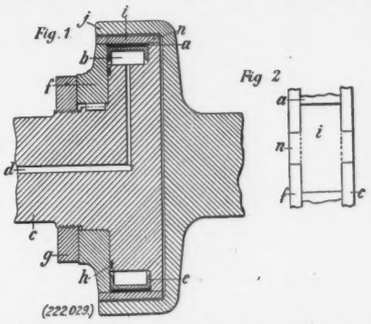
222,908. W. E. Porter, Birkenhead. Winches. (2 *Figs.*) May 12, 1923.—The invention relates to winches driven by electric motors. According to the invention, an armature having a low speed of rotation relatively to a stationary field system is mounted co-



axially with the drum shaft and drives the same either directly or with the interposition of gearing. The winding drums 1 are mounted on a shaft 2 supported by bearings 3 and 4 on the bed plate 5. Mounted co-axially with the shaft 2 is an electric motor 6 comprising pole pieces 7 carried by the bed plate 5 and casing 8 together with armature windings 9 co-operating with the poles 7. The armature windings 9 are mounted on a core 10, the stampings of which are keyed to a sleeve 11 supported by, but rotatable on, the shaft 2. This sleeve is provided at one end with teeth 12 meshing with one or more toothed pinions 13 capable of rotating on stub axles 14 carried by a flanged sleeve 15 mounted on the shaft 2. Rigidly mounted to the bed plate 5 and the casing 8 is a sun gear wheel 16 meshing with the pinions 13 and around which the latter move when rotated by the teeth 12 of the sleeve 11. Arranged within the fixed casing 17 of the sun wheel 16 is a chamber adapted to contain oil, as shown at 18, so that the elements 12, 13 and 16 of the epicyclic gear are lubricated in a satisfactory manner. The casing 18 in which the oil is contained may be provided with suitable packing between the flanged sleeve 15 and sleeve 11 respectively, in order to prevent the oil leaking from the oil receptable into contact with the windings of the motor.—(*Accepted October* 22, 1924.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

222,029. Sir W. G. Armstrong, Whitworth and Co., Limited, Newcastle-on-Tyne, and W. Osborne, Bramhall. Clutches or Couplings. (3 *Figs.*) February 12, 1924.—The invention relates to clutches or couplings for power transmission purposes. The invention comprises the employment for a clutch device between driving and driven elements of an endless band or ring of solid steel or other metal capable of appreciable expansion and contraction under varying pressures applied to its interior surface. The clutch or coupling consists of a thin ring *a* of a metal which will allow of an appreciable extension under load without fracture, housed within an annulus *b* in the enlarged end of a shaft *c*, the annulus being capable of sustaining an internal hydraulic or other fluid pressure applied by way of a passage *d* through the shaft. Leakage past the ring of elastic metal is prevented by a circular leather *e* within the annulus. One side of the latter is formed by a

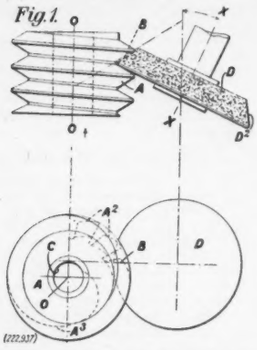


detachable collar *f* keyed to the shaft so that it rotates therewith and is held in place by a nut *g* threaded on the shaft. A packing *h* prevents leakage between the collar *f* and shaft *c*. The pressure of the expansible ring *a* is applied to segmental blocks *i* (see Fig. 2) having lugs *n* thereon which engage recesses in the enlarged end of the shaft *c* and in the collar *f*, so that the blocks rotate with the shaft but can have a radial movement under the action of the ring *a*. The pressure of the segmental blocks *i* is applied to the part *j* of a further shaft *k* which may be either the driving or the driven shaft. When pressure is applied under the expansible ring *a*, the latter expands to an extent not exceeding its elastic limit, and so takes up the clearance between the segmental blocks *i* and the annulus *j* on the shaft *k*. The two shafts *c* and *k* are thereby clutched or coupled together. When pressure is released from under the expansible ring, it contracts, due to its elasticity, and releases the clutch. (*Sealed.*)

222,937. Sir A. Herbert, Dunley Manor, near Whitchurch, and F. W. Shaw, Kenilworth. Grinding Hobs of Worm Form. (3 *Figs.*) July 7, 1923.—The invention relates to the relief grinding of hobs of worm form. According to the invention, the grinding wheel has a bevel edge which is so shaped that the line of contact of its acting edge corresponds with the tooth characteristic and lies in the axial plane of the wheel, and in the grinding process its line of contact is brought into register with the characteristic line of the tooth, and, during the relative movement of the wheel angularly around the hob, this relationship is maintained. The hob A of worm form has its axis at O O, and, in the lower figure, some of the teeth formed by gashing the worm are shown dotted at A^2. The teeth are involute in sections normal to the axis O O, an involute curve being indicated by the dotted line at A^3 in the lower part of the drawing. The straight line characteristic, which exists in such a tooth is shown at B, and is tangential to the base circle C, from which the involute curve is generated. This line B, therefore, is perfectly straight so that it lies evenly on the side face of the tooth. In the arrangement shown in the lower part of the drawing, a prolongation of this line radially outward from the hob cuts the axis X X of the grinding wheel D, and thus appears to extend through the centre of the wheel. The grinding wheel D has a straight-sided bevelled periphery D^2 for the involute teeth shown. It is slanted at such an angle that its bevelled edge can bear upon the "straight line" or the curved portion or characteristic line of the hob tooth, while the face having the largest diameter will clear the

adjacent tooth with a safe margin. The axis X X of the grinding wheel will, therefore, be inclined to the axis O O of the hob A, at such an angle as will bring its acting straight or curved edge into register with the appropriate position of the hob tooth at which the characteristic line is situated, as above specified. The advantage of using a bevelled grinding wheel in the manner just described is that the curvature of the acting periphery away from the contact line provides a considerable amount of clearance from the face of an oncoming tooth, while effecting relief grinding

Fig. 1.



Thus, it is not necessary to make the gashes appreciably wider than usual to enable the grinding wheel to act from end to end of each tooth. With the foregoing arrangement the relative movement of the work and the grinding wheel would be such that the latter travelled along the spiral hob tooth from end to end, or to the limit above referred to, thereby accurately shaping the tooth profile. Obviously, by a suitable arrangement of two grinding wheels, both sides of the tooth could be ground at the same time.—(*Accepted October* 22, 1924.)

222,059. C. Jones, Lower Broughton, Manchester. Aligning Bearings. (4 *Figs.*) May 19, 1924.—The invention relates to adjustable supports or mountings for aligning bearings. A mounting, in accordance with the invention, comprises a cylindrical outer member *b* adapted to rotate and be adjusted and secured within a housing or frame *a* and an oblique inner member *d* mounted to slide within the outer member *b*. The outer member *b* is bored through its centre obliquely to the axis of its external cylindrical shape, thereby forming a hole *c* of true circular cross section. The inner member *d* is cylindrical and its ends are shaped off obliquely to lie parallel with the faces of the outer member *b*. The inner member *d* is bored through its centre obliquely to the axis of its external surface forming a hole *e* of true circular cross section, the obliquity of the hole *e* with respect to the other surface of the member *d* being the same as the obliquity of the hole *c* with respect to the outer surface of the member *b*, whereby the axis of the hole *e* is arranged parallel to the axis of the outer

Fig. 1.

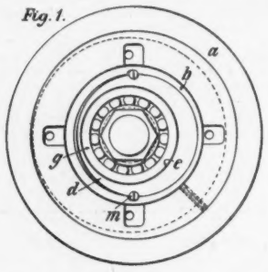
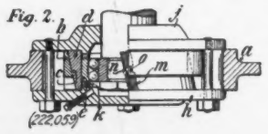


Fig. 2.



cylindrical member *b*, the inner member being constrained to axial movement only within the outer member. A shaft is mounted on a bal. race, the outer member *g* of which is disposed in the hole *e*. Back and front plates *h* and *j* are provided on the bracket *a* to retain the inner ring *d* against axial displacement, and distance pieces *k* are provided to locate the outer member *g* axially in the bracket. Adjusting screws *m* are disposed in grooves in the outer face of the inner member *d* and lie parallel to the axis of that face. They are each formed with a waist *n* in their centres, which engages with a central projection *o* placed in the grooves. Correspondingly threaded grooves are formed in the inner face of the hole *c*. Thus, the inner member may be adjusted in the outer member along the oblique axis by turning the screws *m*. In operation, the hole *e* may be set eccentrically to the outer surface of the part *b*, and the part *b* may be turned in the bracket so as to determine the angular direction of such displacement. The mounting is therefore capable of employment for aligning bearings within the limits of the eccentricity obtainable from the oblique displacement of the inner member within the outer member. (*Sealed.*)

MOTOR ROAD VEHICLES.

222,927. F. P. Hailey, Birmingham, W. J. George, Birmingham, and L. E. Little, Norbury. Grease Guns. (3 *Figs.*) July 4, 1923.—The invention relates to the disconnectible type of valved connection or coupling provided on the ends of the flexible tubes of lubricating grease or oil-feed devices known as grease guns. The invention consists of a valved connection or coupling in which the longitudinally sliding sleeve ordinarily provided on such valved connections or couplings is replaced by a rotating controlling sleeve, the sleeve, and the valved body on which it is arranged, being provided with means whereby their relative partial rotation can be readily effected by pressure of the thumb and finger, the rotation being effected against the action of a tension spring occupying a recess in the sleeve. The main tubular part of the coupling is provided near one end with a number of recesses 7 for the reception of balls 8. The balls 8, when in their normal position, *i.e.*, pressed inwards, provide the means whereby the coupling is locked on the nipple 9. Mounted on the tubular body 6 is a sleeve 10, which is secured between a shoulder 6*a* and a screw ring 11 on the externally screwed end of the body. The body 6 and sleeve 10 are each provided with a lug such as 6*c* and 10*a* respectively,

Fig. 1.

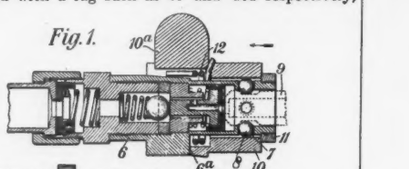


Fig. 2.

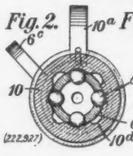
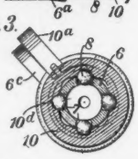
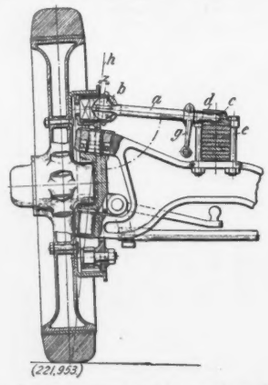


Fig. 3.



which constitute means whereby the body and sleeve may be rotated relative to one another, pressure of the said parts between the thumb and finger serving to move them from the position shown in Fig. 2 to the position shown in Fig. 3. The body and sleeve are normally preserved in the relative position, shown in Figs. 1 and 2, by a coiled torsion spring 12, one end of which is anchored to the body 6, its other end engaging the sleeve 10. The sleeve 10 has in the inner wall thereof a series of pockets 10*d*. The pockets, in the normal position of the body and sleeve, are out of alignment with the locking members, which members are retained in the inwardly pressed position by the contact therewith of the parts of the inner wall of the sleeve between the pockets or recesses as is best seen in Fig. 2. When making or disconnecting a coupling it is only necessary to pinch the lugs or earpieces 6*c* and 10*a* between the thumb and finger in order to bring them together, thus effecting relative rotation of the sleeve and tubular member, and bringing the locking members into alignment with the pockets so that they can move into the unlocking position, as shown in Fig. 3. On release of the pressure on the operating lugs or earpieces, the parts automatically return to their normal positions.—(*Accepted October* 22, 1924.)

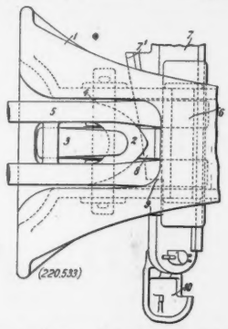
221,953. J. M. Rubury, London. Front Wheel Brakes. (1 *Fig.*) September 19, 1923.—The invention relates to front wheel brakes and comprises the arrangement of the brake shoe operating cams above the steering pivots so that the controlling gear for brakes is clear of the levers, rods and connections associated with the



steering mechanism arranged with regard to the pivotal steering axes. The brake operating shaft *a* connected with the universal joint *b* is supported at the end *c* in a bearing *d* in which it can rotate and/or slide, this bearing *d* being mounted above the upper leaf of the front spring *e*. The relative vertical elevations of the ends of the shaft *a* are so arranged that, assuming that the lever *g* is rotated backwards out of the plane of the paper to apply the brake, the angle between the axis of the shaft *a* and the pivotal steering axis *h* associated therewith is slightly in excess of a right angle, the effect of which when coupled with the effect produced by the displacement *z* of the centre of the universal joint *b* from the pivotal steering axis *h*, produces the desired variation in braking effect (when fitted to both front wheels) on one front wheel relative to that exerted on the other front wheel, when the axes of the front wheels are angularly displaced for steering and the braking apparatus is operated. By this arrangement the brake gear control rods connected to the levers *g* can be easily disposed clear of the steering mechanism. (*Accepted October* 1, 1924.)

RAILWAYS AND TRAMWAYS.

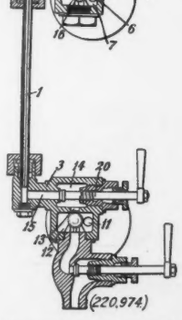
220,533. J. Mitchell, Putney, London, and J. C. G. Cossey, Golders Green. Couplings. (4 *Figs.*) December 7, 1923.—The invention relates to coupling devices for railway vehicles in which the coupling is effected by means of a locking bar adapted to slide in the coupler head. 1 is a coupler head, 2 a shackle, the end of which is engaged in a recess provided in a disc hook 3 pivoted on a pin 4. The shackle 2 is pivoted on the adjacent coupler head (which is not shown) and lies below a similar shackle 5 pivoted on a pin 6. The coupling is effected by the engagement of a locking bar 7 in a recess



8 of the disc hook 3, and, in the example illustrated, a wedge shaped portion 7[1] is urged by spring pressure to rotate the disc hook to maintain the coupler heads in tight contact. To release the coupling at any time, the locking bar 7 must be moved against the spring pressure until a recess 9 provided in the bar is opposite the disc hook 3, which is then free to rotate into the uncoupling position. A latch 10 is provided in order that it shall be impossible for the locking bar by an unintentional displacement to be moved so that the recess 9 is opposite to and frees the disc hook. (*Sealed.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

220,974. R. Parker, Dorchester, and J. H. Corbin, Bournemouth. Boiler Water Gauges. (2 *Figs.*) January 11, 1924.—The invention relates to gauge mounts in which a ball is used to close automatically a passage and cut off the steam and/or water should the glass tube break. The usual gauge glass 1 is arranged between the upper mounting 2 and the lower mounting 3. The steam connection to the upper mounting is at 6 and the steam passes therefrom through box 7, opening 8, chamber 9 and passage 10 to the upper end of the glass



tube. In much the same way the water enters the lower mounting at 11 and passes through box 12, opening 13, chamber 14 and passage 15 to the lower end of the tube. In box 7 a metal ball 16 is provided and normally leaves the opening 8 free. If the glass breaks, the rush of steam through the box 7 will lift the ball and close the opening. A screw-down valve 18 is arranged in the chamber 9 and can be turned to close the passage 10. In the lower mounting a ball is contained in the box 12 and normally rests so that the opening 13, chamber 14 and passage are open to the water. In this mounting the screw valve 20 is capable of closing the passage 15. (*Sealed.*)